THE
ENGINEERING REVIEW.

Edited by

C. EDGAR ALLEN.

Vol. XVII. NOVEMBER, 1907. No. 5.

# The Modern Single-Phase Railway Motor.

*II.*

## SOME OF ITS CHARACTERISTICS.

*By ANDREW STEWART, A.M.I.E.E.*

In actual practice the stopping and reversing of the electric current in the coil under commutation is simplified by two methods: one is by reducing the number of turns connected to the commutator segment to the smallest possible amount—often in single-phase motors only one—which is equivalent to reducing the weight of a flywheel; the other by compensating coils, which, by neutralising the armature reaction, to a large extent prevents distortion of the field magnetism, and so allows the small amount of field magnetism which is available at this point, to reverse the current in the coil under commutation as quickly and easily as possible.

Fig. 3 shows the relative position of the field magnet *B*, the armature *A*, and the compensating coil *C*. It will be apparent from this that the magnetic field due to the field magnet lies in the direction of the heavy arrow, while the field due to the armature is in the direction of the broken arrow. The field due to the compensating coils, denoted by the double-headed arrow, is exactly opposite to the armature reaction, and, therefore, tends to neutralise it.

The most usual diagram used to illustrate the compensated single-phase series motor is shown (Fig. 4), where *A* is the field magnet coil, *B* the armature, and *C* the compensating coil, the latter being shown at right angles to the field coil for the reason already indicated.

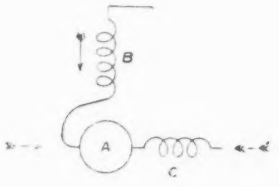


FIG. 3.

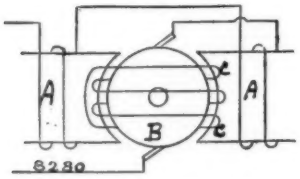


FIG 4.—DIAGRAM OF COMPENSATED SERIES MOTOR, SHOWING LOCATION OF COMPENSATING COILS IN POLE FACE.

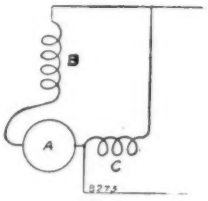


FIG. 5.

It will be noticed that this compensating winding is wound across the pole face on the field magnet, and is in this instance short-circuited on itself for a reason which will be explained later.

It illustrates the general arrangement of the single-phase series motors as made by the Westinghouse and Siemens-Schuckert Companies. The General Electric Co., of United States, America, also use this type of single-phase railway motor, but the British Thomson-Houston Co., who are to some extent allied with the American General Electric Co., use a different type of single-phase motor, which will be described shortly.

It should be pointed out here that although the diagram (Fig. 3), shows the current passing through the field magnet coils, then through the armature and subsequently through the compensating coils, there are alternatives to this. Figs. 4 and 5 show these. The first shows diagrammatically an early type of compensating coil consisting of the compensating coils already shown (Fig. 3), short-circuited on themselves and in no way connected to the supply circuit. Such a coil would have currents induced in it due to the variations of the current and magnetic field in the field magnet; indeed, it would act just as the secondary coil of a transformer, the field magnet coil being the primary. Fig. 5 shows the compensating coil connected in shunt to the armature and field magnet. These alternative methods do not alter the principle underlying the apparatus, being merely other methods of supplying current to the compensating coils. Fig. 5 has been adopted by Messrs. Siemens-Schuckert with the addition of resistances in series with the armature coils and the commutator bars. Such motors are used on several European railways, the line from Murnau to Ober Ammergau already mentioned, and on some of the locomotives on the Swedish State Railways*.

The compensated repulsion motor is, perhaps, the motor which has received most attention from English electrical engineers; it differs in many important respects from the compensated series motor.

This motor bears some resemblance to the series motor, inasmuch as some current may pass through the armature directly from the field magnet. In addition the motor is provided with a pair of brushes set at right angles to the usual brushes, through which the armature current passes. These brushes introduce the modifying feature which serves to distinguish this type of motor from its simpler rival.

Fig. 6 shows the connections of this motor, *A* being the armature, *B* the field magnet, and *D* the short-circuiting brushes. This type of motor was evolved by Messrs. Winter and Eichberg, and is made by the British Thomson-Houston Co. in England, and The Allgemeine Elektricitäts Gesellschaft in Germany. They are especially interesting, as they will be used on The London, Brighton and South Coast Railway electrification scheme, and are in use on the Swedish State Railways, by the Altona Railway Board at Hamburg, and many other lines.

The principle on which these motors work is derived from the elementary

* THE ENGINEERING REVIEW, February, 1906, p. 149.

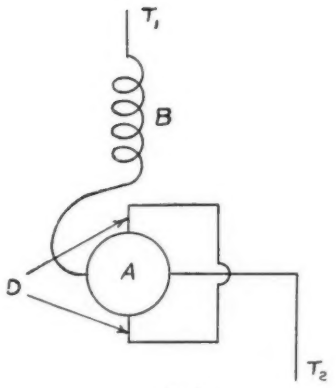


FIG. 6.

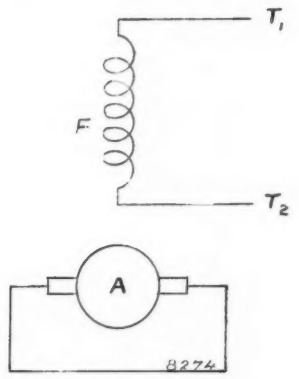


FIG. 7.

fact that a current carrying coil of wire, if suspended between the poles of an electro magnet excited by an alternating current, tends to set itself so that it embraces no lines of magnetic force; that is, it will set up a field of its own which will be repelled by the field due to the magnet, and as the latter is, of course, constantly changing, due to the alternating nature of the current, the coil is constantly moving out of the field so created.

The current in the armature is not necessarily supplied to it by any external connection, but may be a simple machine with an externally excited field, *F*, and an armature *A*, having brushes which are connected together as shown (Fig. 7), but with no connection to the source of supply. It should be explained that the action of a repulsion motor so connected is analogous to some extent to an ordinary induction motor; indeed, Mr. V. A. Fynn, in his paper to the Institution of Electrical Engineers, has termed the repulsion motor a series induction machine, and in so doing he has coined a term more correctly descriptive of the type than that usually applied.

The action of the alternating field in the fixed part of the motor at *F* (Fig. 7) is to induce a current in the windings on the armature *A*. This current will tend to make the armature coils below the pole pieces of the field magnet move out of the influence of the magnetic field set up by the current in the field coils, this process bringing another group within the sphere of the magnetic field, which is in turn driven out, so that there is a continuous movement of the armature coils out of the influence of the field magnet poles.

Repulsion motors of this type have the advantage that, as no line current enters the armature, high line pressures may be used without transformation; no troubles due to sparking at the commutator will be experienced, and the field magnet windings being fixed, and therefore more easily insulated, can easily carry high line pressures which would not only be a source of trouble but of weakness if allowed on the armature.

Such a machine may have its speed varied by simply moving the brushes round the commutator. It has, however, the inherent defect that it has a low starting torque, and various modifications have been introduced to cure this.

One method of getting over the difficulty is to embody the series motor and the repulsion motor in one machine, and this, or a slight modification thereof, is the form in which the compensated repulsion railway motor of to-day is

most frequently found. The connections of such a machine have been shown diagramatically (Fig. 6), and the fact that it resembles the series machine will be apparent while the short-circuited brushes, characteristic of the simple repulsion motor are embodied in the design. This machine is not compensated in the same sense as the compensated series motor already described, but is compensated by the action of the short-circuited brushes.

As is well known, the plain repulsion motor such as has just been described, acts like an alternating current transformer—*i.e.*, the field current induces the secondary or armature current, and the brushes short circuit the latter, hence it is analogous to an ordinary alternating current transformer with the secondary short circuited. The effect of this secondary or armature current is to neutralise the self-induction of the field winding, which improves the power factor, and with it the torque, especially at starting. It should be explained that the power factor is dependent upon the self induction of the apparatus, and that when the self induction is considerable, a wattless or parasitic current flows in the windings which does not represent power at all, but merely an idle current circulating to and fro in the windings, which, while doing no work, makes the current as read on the ampere meter high, and gives the impression that much work is being done. The ratio of the true, or power current, to the apparent current—the latter includes, of course, this idle current—is designated the power factor. The torque is proportional to the true and not the apparent current, so that the connection between torque and power factor will be appreciated.

These short-circuiting brushes on the repulsion motor, by acting as the short-circuited secondary of a transformer, reduce the self induction of the field magnet windings, and so give a machine of higher power factor, while the series current gives the machine the high starting torque which is characteristic of this type of machine.

We have, however, re-introduced the practice of passing the field current through the armature. While this is quite satisfactory for lines operating on low pressures, railway service demands high voltages if the requisite economy is to be attained.

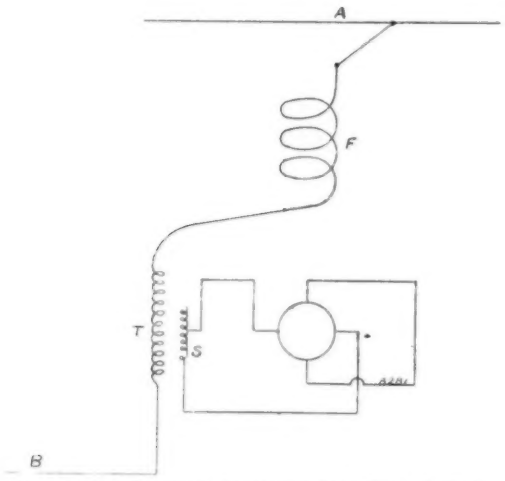


FIG. 8.—DIAGRAM SHOWING CONNECTIONS OF "WINTER-EICHBERG" COMPENSATED REPULSION MOTOR.

This difficulty has been satisfactorily solved by Messrs. Winter and Eichberg, who have supplied the series armature current from a transformer, the primary of which is in series with the field connection. Fig. 8 shows this arrangement where the current from the trolley passes from *A* to *B*, first through the field coil *F* then the primary of the transformer *T* to the rail return at *B*. The secondaries of the transformer have taps taken off at various points for the purpose of varying the pressure and current passing through the armature independently of that in the other parts of the motor winding. Thus speed control can be obtained without the loss of power inherent to rheostatic control.

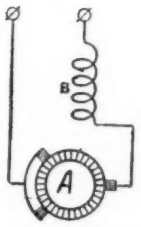


FIG. 9. — BRUCE-PEEBLES METHOD OF CONNECTING REPULSION MOTOR.

Any of the foregoing motors can be used on direct current circuits of suitable pressure by simply supplying the direct current through the trolley wire, and controlling it in the ordinary way by means of a controller and resistances. The probable use of direct current determines whether or not high pressure single-phase currents will reach the motor at all. If it is at all likely that direct current will be employed, or if the train may run over a section of the line operated by direct current, a transformer must be introduced between the line and the motor which transforms the high pressure single-phase current down to a lower voltage, usually 200 to 600 volts. When operated on the single-phase circuit the motors are frequently wound for some voltage near the lower limit named, and operated in groups of two in series, speed control being obtained by varying the pressure on the armature by means of taps from the secondary of the transformer, as shown (Fig. 8). When a change of supply is made, and it becomes necessary to operate on direct current, the current is switched over to an ordinary direct current tramway or railway controller, and the two motors, formerly operated in series, are first operated in this way, and then switched over to parallel as is universal with direct current tramway and railway practice to-day. The short-circuiting brushes on the repulsion motors are, of course, open-circuited, and the motors become ordinary series direct current machines. There is one difference, however, which need not at this point concern the engineer, but which will shortly be dealt with, viz., the arrangement of the field winding, which is usually distributed in several slots per pole, instead of the usual winding on poles projecting radially inward, such as the usual direct current tramway or railway motor.

Messrs. Bruce, Peebles & Co. have modified and to some extent improved the "Winter-Eichberg" arrangement by reducing the number of brushes on the commutator to three. This is effected in the case of an ordinary repulsion motor, by connecting it as shown (Fig. 9) where *S* is the series field winding, the short circuiting brushes on the armature *A* having an additional connection to the other wire of the line. A comparison of Fig. 9 with Fig. 6 will make the arrangement clear.

### THE CONSTRUCTION AND PERFORMANCE OF SINGLE-PHASE RAILWAY MOTORS.

This may closely resemble contemporary direct current railway motors, or, on the other hand, may differ widely therefrom, and machines exhibiting this remarkable difference have proved uniformly satisfactory; hence designers have a good deal of latitude when approaching the subject. The "Westinghouse" single phase motor is an excellent example of the compensated series motor with polar projections just as in a direct current motor, while the opposite extreme, the "Winter-Eichberg" compensated repulsion motor which will be used on the London, Brighton and South Coast Railway, is a good example of the type of motor which has a field magnet just like the stator, or field magnet, of an induction motor, *i.e.*, having no polar projections, but instead having the exciting winding distributed in slots round the inner face of the stator.

One reason for the choice of a single-phase motor with a smooth interior on the field magnet is that such a design lends itself well to the construction of motors suitable for use on circuits of high periodicity. As is well known, this question of periodicity (or frequency), or the number of alternations of the alternating current, is one of some importance, and in many cases railways that are just developing may find it commercially expedient to purchase their

power from some existing power station whose supply is not always suited to single-phase motors. For instance, the periodicities found most suitable for single-phase motors are between 15 and 25 cycles per second, but most electric power companies in England and abroad have developed their systems with 40 to 60 cycles, the usual being 50 cycles, except in the United States of America where there are several important 60 cycle systems. While of course it is quite possible to use a frequency changer so that a suitable periodicity may be obtained, this is undesirable inasmuch as it imposes an additional burden on the undertaking in the shape of capital charges on the apparatus, and losses in conversion, both of which are likely to be avoided by railway engineers, owing to the increasing difficulty in making the capital already sunk in the system sufficiently remunerative.

The single-phase motor having no polar projections makes possible the efficient use of periodicities of 40 to 50, and even 60 cycles. The reason for this is that in a single-phase motor, the field magnetism, instead of being a fixed quantity, varies rapidly, owing to the fluctuating nature of the alternating current. The nature of these fluctuations are of course well known, as the general principles of alternating currents have been expounded. So long as these fluctuations are comparatively small, such as from 15 to 25 cycles per second, polar projections do not matter much as they are few in number and the changes in the magnetic flux not serious. By increasing the periodicity of the supply current, we increase the number of changes in the magnetic field and *pro rata* the speed, if the number of poles are kept small; as, however, the speed must be kept within well defined limits, we are confronted with the necessity of increasing the number of poles to achieve this end, though in so doing we increase the cost while the increase in the periodicity, by increasing the number of changes in the field magnetism, makes it essential that the inner side of the field magnet should be as regular as possible if magnetic leakage, and considerable eddy currents in the surrounding motor frame, are to be avoided.

Thus any increase in periodicity demands a change in construction, though in any case a uniform design without polar projection may be desirable in the interests of uniformity in manufacture, and for that reason some makers construct single-phase railway motors for all periodicities having a field magnet which presents practically a smooth inner surface, resembling in fact the armature of a direct-current motor turned outside in.

The field magnet of the first type of single-phase motor, viz., a machine with polar projections is illustrated (Fig. 10). This is a "Westinghouse" machine having four poles, and a winding *A* on each, just like the standard direct-current tramway and railway motor of to-day. There is, however, one important difference, viz., the face of each pole is pierced with a number of holes, or slots *B*, in which lies the compensating winding, this and the main winding have been shown diagrammatically in Fig. 4, and the object of the two windings already explained.

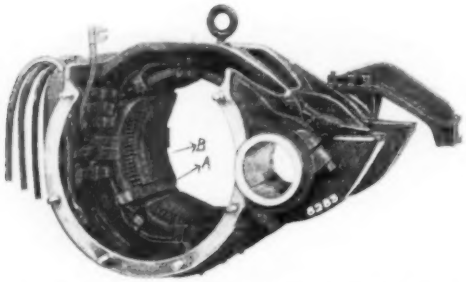


FIG. 10.—FIELD OF "WESTINGHOUSE" SINGLE-PHASE MOTOR.

The armature of such a machine, which has of course been removed, is indistinguishable from a standard direct-current armature, and requires no comment.

An example of a motor having no polar projections on the field magnet is the "Winter-Eichberg"

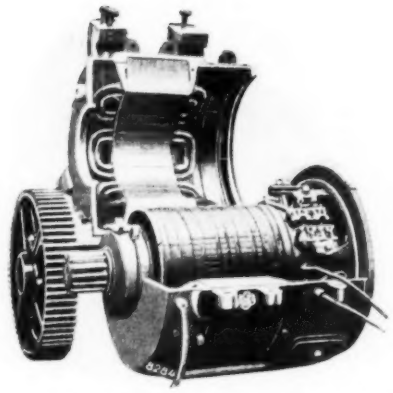

FIG. 11.—"WINTER-EICHBERG" SINGLE-PHASE RAILWAY MOTOR.

machine illustrated in Fig. 11. Here we have a field magnet which presents practically a smooth surface to the armature. The surface is, as a matter of fact, broken only by narrow openings which give access to the slots or tunnels which contain the exciting winding.

Each heavy convolution seen in the upturned portion of the field magnet really consists of a number of wires or pieces of copper strip, these wires or bars being taped together outside the slots. The machine is a 40 h.p. motor made by the Allgemeine Elektrizitats Gesellschaft, and resembles the motors which will be used on the London, Brighton and South Coast Railway. It will be seen that this field magnet winding really resembles the stator of an induction motor; the effect of distributing the winding in a number of slots does not materially alter the action of the machine, the effect of windings so grouped is just like the more usual direct-current machine, the field magnetism being induced by the current flowing in the wires.

*(To be concluded.)*

## British Standard Specification for Portland Cement.

THE British Standard Specification for Portland cement, Report No. 12, has now been revised and published. Among the more important points in which revisions have taken place are the following:—

1. The percentage of sulphuric anhydride has been slightly raised. 2. The quantity of cement to be used in the test for fineness and the period for which it is to be sifted have been specified, while the residue to be left on a sieve 180 by 180 has been somewhat reduced. 3. The grading for the increase of tensile strength in the neat test has been further extended. 4. The maximum final setting time for the "slow setting" cement has been increased. 5. The expansion under the Le Chatelier test has been reduced.

Other investigations and experiments are being undertaken by the committee, some of which have reference to a stipulation as to the initial setting time. These results, however, may not be expected for some time.

# Testing a Centrifugal Fan.

*II.*

*By C. L. BROWNE.*

*Pitot Tube.*—If a water gauge tip be bent round so as to face a current of air flowing into the atmosphere, it may be used to measure the velocity of flow.

The pressure which a stream of air issuing into the atmosphere from a vessel under pressure may exert upon any surface with which it comes into contact will depend upon the size and shape of the surface, and upon the angle of incidence. If this stream of air were to strike a plain surface at right angles, the theoretical relation between the resulting pressure in feet of air and the velocity of flow would be expressed by the well known formula—

$$H = \frac{v^2}{g}.$$

Thus it might appear that this would be the reading given by the pitot tube or facing gauge. That is to say, that the facing gauge would give a reading equivalent to twice the height due to the pressure which was actually required to give air the velocity in question.

Experiments, however, including both those made by Messrs. Heenan and Gilbert and those of the Russian Mining Commission, prove that the air impinging upon the end of the pitot tube does not lose the whole of its momentum parallel with the axis of the tube, but that

$$H = \frac{V^2}{2g},$$

so that, provided that there is no static pressure present, the velocity in feet per minute corresponding to the reading in inches of water obtained with the pitot tube may be ascertained for any particular conditions from Table I. This will be clearly shown later by means of a practical example, but it must be recognised that the existence of any static pressure or any deviation of the angle of incidence from a right angle to the face of the tip will falsify the conclusions drawn from the reading of the gauge.

When using the manometer as a pitot tube, it will be found in practice that, owing to the large expenditure of power required to produce high velocities as distinct from high pressures, the velocities usually met with in transmission ducts are low, and the readings on the ordinary water gauge when used to measure velocities only will be very small, and the difficulty of obtaining accurate readings considerable.

To overcome this difficulty, the writer has made a practice of using for the above purpose a manometer in which advantage is taken of the difference in specific gravity of two liquids not intermissible.

Fig. 4 is a diagrammatic representation of the instrument referred to.

*A* is an ordinary bent glass tube about 20 ins. high, with a graduated scale at the back of it. The bottom portion of the tube is filled with an artificial oil known as nitro-benzole and the remainder of the *U* tube is filled with water up to the level of about one-half of the height of the two closed vessels *C C* to which the *U* tube is connected. On the top of these two vessels are fitted two short nozzles *D D* to one or both of which the tip or tips are connected as with the ordinary water gauge. The upper surface of the water in these two vessels must be very large compared with the cross-sectional area of the columns of liquid in the tube, so that when a considerable movement in the respective levels of the surfaces of the nitro-benzole takes place, the alteration in the level of the surfaces of the water in the containing vessels *C C* will be negligible.

The vertical movement of the surfaces of the columns of the nitro-benzole under the influence of unequal pressure on the surfaces of the water in the vessels *C C* will now vary inversely as the difference in the specific gravity of the two liquids employed.

For instance, if the specific gravity of the nitro-benzole be 1·25, the movement of the upper surfaces of the columns of nitro-benzole under a given pressure will be four times as great as that obtained in an ordinary water gauge. The difference in the specific gravity of the two liquids employed can be easily ascertained by balancing in the *U* tube a column of the one against a column of the other under atmospheric pressure, and noticing the difference in their respective heights. The scale at the back of the *U* tube can then be graduated accordingly.

Another method of taking readings from the pitot tube is by use of a dial draught gauge. This was the method adopted by Bryan Donkin in his series of fan tests conducted in the years 1893 and 1894, and very accurate results may be obtained by means of a reliable instrument. Having obtained the velocity of the effluent air, it will be necessary to know the effective area of the orifice from which the air is issuing in order that the volume of the air discharged may be correctly calculated, and under no conditions is the effective area for flow equivalent to the full actual area of the orifice.

The volume of air discharged through a given orifice is largely dependent upon the character of the latter, and this is due to the following facts: Firstly, that the direction of the molecules of air is not always parallel with the mean line of flow at the point of efflux, and consequently, the resultant velocity along the mean line of flow is less than that theoretically due to the pressure producing it; secondly, that the area of the stream of air is considerably reduced at a distance from the opening equal to about one half of its diameter. Thus, in order to obtain the effective discharge area which may be multiplied into the velocity corresponding to the pressure producing it, in order to obtain the volume discharged, the actual area must be multiplied by suitable co-efficients both of velocity and of contraction, the co-efficient including both, which may be called the co-efficient of efflux, being very considerably less than unity. The correct values for the co-efficients of efflux for various forms of orifice have been a matter for mathematical speculation and experimental research from time to time, and the difficulty of arriving at reliable figures may be realised from the fact that authorities such as Weisbach, Lelong and the Prussian Mining Commission differ considerably among themselves.

It would be out of place in this article to refer to the various experiments made, and the different results obtained, but the general results for three different forms of orifices are given in Fig. 5. The most reliable value appears to be that given for a circular orifice in a thin plate which was found by the Prussian Mining Commission in their experiments at Breslau to be ·64 for orifices up to about 10 ins. in diameter, and as the air used in these experiments was discharged from a gasometer, and the measurements made very carefully checked, this value is probably correct for orifices up to the diameter given. From experiments made by the writer it would appear

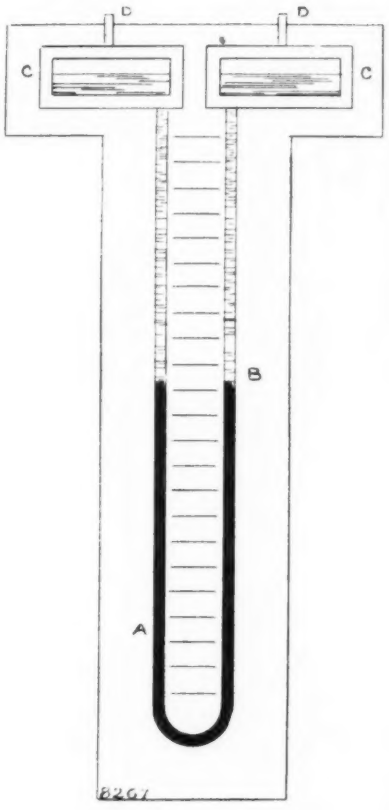


FIG. 4.

that this co-efficient increases in value for larger orifices, being probably ·66 for an orifice 30 ins. in diameter.

Returning for the moment to the various methods for computing the work done by a centrifugal fan, as enumerated above, it becomes evident that a fan can, through absence of care and a proper experience during the test, be made to show a grossly exaggerated capacity.

The indiscriminate use of the anemometer, the inductive effect of the air flowing across the water gauge tip in the fan inlet, and the failure to make a proper allowance for the *vena contracta* of the orifice used, have in turn often served to give to an ordinary fan a more or less brief reputation.

Even in cases where the greatest care

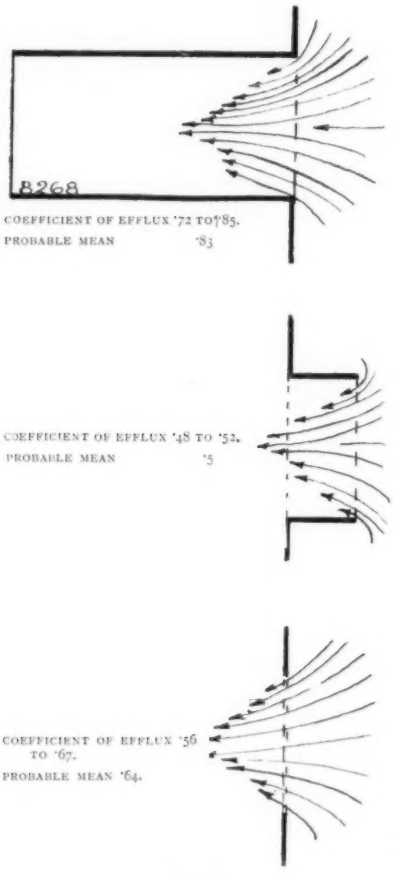
8268
COEFFICIENT OF EFFLUX '72 TO '85.
PROBABLE MEAN '83
COEFFICIENT OF EFFLUX '48 TO '52.
PROBABLE MEAN '5
COEFFICIENT OF EFFLUX '56 TO '67.
PROBABLE MEAN '64.

FIG. 5.

has apparently been taken to obtain correct readings, it has occasionally been found on looking into the formula used in working out the efficiency of a new design of fan, that the kinetic energy remaining in the air after leaving the fan has been added to the amount of useful work performed.

Fig. 6 is a diagrammatic representation of a fan under test, in which side and facing gauges are being used, an inlet and outlet connection having been fitted to the fan in order to allow the pressures and velocities of the air to be measured. First assume that the fan as at *A* (Fig. 6) is working with free inlet and outlet—that is to say, that the fan is drawing in air from the atmosphere and discharging it at the same pressure—as there is no pressure difference at the fan outlet and inlet it is obvious that the fan is doing no useful work, its efficiency in this case being zero.

However, the side tip *X*, placed in the inlet connection, shows a considerable reading which obviously cannot be credited as useful work to the fan. The reading on the manometer corresponds to the velocity head of the air flowing into the fan, the latter having the assistance of this amount of kinetic energy. The correct static water gauge in this case will be given on the facing gauge *Y*, which is turned to meet the inflowing current of air, and as previously shown, the air impinging against this tip will exactly neutralise the vacuum due to the velocity head, and the true static water gauge set up by the fan will be correctly given as zero.

Assume that the temperature of the air is 62° F., and that the reading on the side gauge *X* is half an inch, the velocity corresponding to this reading will be found in the table to be 2,830 ft. per min, and if the effects of induction be entirely neutralised by the form of tip used, this will be the velocity of the air flowing into the fan.

Assume the co-efficient of influx at the entrance to the inlet tube to be ·83, and its sectional area 2 sq. ft., the volume of air drawn into the fan per minute will be $2830 \times \cdot 83 = 4697 \cdot 8$ cub. ft.

Turning now to the discharge box, as there is no static pressure, the side gauge *X* will not register any displacement. The water gauge *Y*, however, which has a side tip connected to one of its legs, and a facing tip to the other leg, shows a certain dynamic head to exist. As the fan is passing 4697·8 cub. ft. of air per min., and the sectional area of the discharge connection is, say 4 sq. ft., the air velocity will be $\frac{4697 \cdot 8}{4} = 1174 \cdot 4$ ft. per min., and the corresponding height in the water gauge will be ·086 (approx.) since the static pressure upon the other surface of the water in the gauge is zero.

According to Weisbach, Bryan Donkin, and others the mean velocity of flow in a circular pipe may be obtained by placing the facing tip at a distance from the centre of the pipe equal to two-thirds of its radius. If the velocity of the air is not uniform over the discharge area of the fan, the mean velocity of flow would have to be computed by dividing the cross area of the discharge pipe into a number of equal imaginary areas, and taking the velocity of the air in each. It should, however, be noted

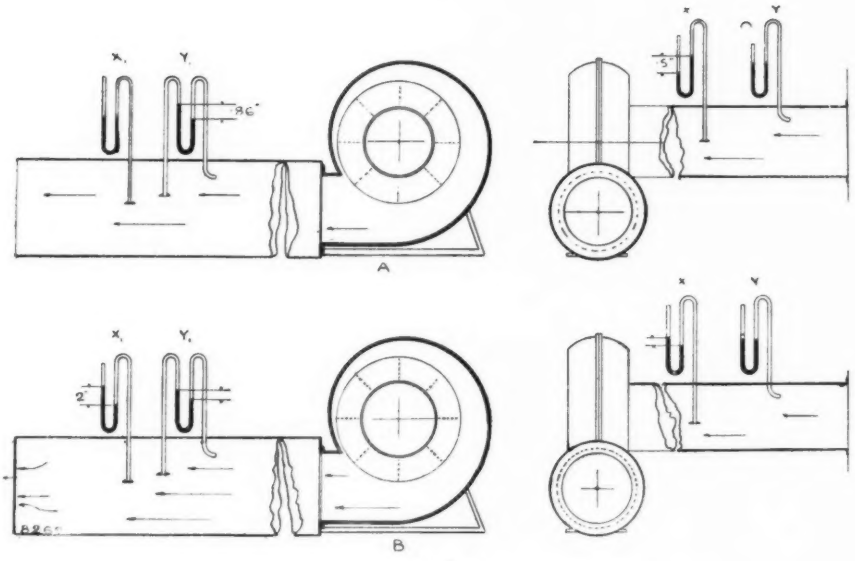


FIG 6.

that the mean velocity will be that corresponding to the mean of the squares of the various readings of the water gauge.

Suppose now that a thin plate with an opening through it of an actual area of ·156 sq. ft. has been placed at the outlet of the discharge connection as in *B* (Fig. 6).

As the area available for flow of air has now been decreased, provided that the speed of the fan remains unchanged, a less quantity of air will be delivered. The water gauge *X* will now show a considerable reading due to the compression by the fan of the air in the discharge box. Assume this reading to be 2 ins., then by reference to the table it will be seen that the corresponding velocity of efflux is 5,650 ft. per min., and if the coefficient of efflux for this form of orifice be ·64, the effective discharge area will be (·156 × ·64) = ·1 sq. ft., and the number of cubic feet of air delivered per minute 565.

Turning again to the inlet connection, the water gauge *Y*, connected to the facing tip will still show no reading, but the gauge *X* connected to the side tip will give a reading due to the velocity head of the entering air. Since 565 cub. ft. of air per minute are passing through the fan, the velocity of the air in the inlet connection will now be $\frac{565}{2 \times \cdot 83} = 341$ (approx.) ft. per min., and therefore the displacement in this gauge will be too small to be appreciable.

Thus the fan may be said to be drawing in air at atmospheric pressure and forcing it into the discharge box at the rate of 565 cub. ft. per minute against a pressure head equivalent to 2 in. of water, and this is the useful work performed by the fan. Now if would be possible by decreasing the inlet area and speeding up the fan to deliver air drawn in from the atmosphere at the same rate against the same head, and although the necessarily increased air velocity through the fan inlet would cause a higher reading in the gauge *X*, the useful work done by the fan would still remain the same. More power would be required to drive the fan, and its mechanical efficiency would obviously fall.

As instancing the exaggerated capacity sometimes attributed to centrifugal fans, the writer has a recollection of having had occasion to check the efficiency confidently said to be obtained with a special type of induced draft fan installed in connection with a steam boiler plant and discharging into a brick chimney.

The velocity of the gases had been accurately measured at the outlet from the economiser flue, and this velocity being

multiplied by the known area of the flue at the point of measurement, gave the volume drawn through the fan as very nearly 100,000 cub. ft. of gases per min. A piece of ¾ in. pipe was inserted through a hole made in the inlet pipe close to the fan, and the water gauge when connected to this pipe gave a reading of 3·15 in.

From this the horse power in the air was worked out to be $\frac{3{\cdot}15 \times 100{,}000}{6{,}352} = 49{\cdot}5$ say.

As the b.h.p. given out by the motor driving the fan was at the time of the test 65, the mechanical efficiency of the fan was assumed to be $\frac{49{\cdot}5}{65} = 66{\cdot}2$ per cent. approximately.

As the fan in question was well known to the writer to be unable to give this efficiency even at its best working orifice, it was decided to check the above readings. A non-inductive tip was first inserted into the fan inlet and the reading obtained −3 ins. and a deduction of ·15 was made from the previous reading as being due partly to the gauge being fixed so as to partially face in the direction in which the gases were flowing, and partly to the inductive action of the gases flowing across the tip then used.

By dividing the volume passing into the fan by the area of the inlet pipe, it was found that the velocity of the gases in this pipe was approximately 3,800 ft. per min., and as the temperature of the gases at this point was 500° F., the corresponding water gauge to be deducted from that previously attributed to the fan was −·5 in.

In addition to the above observations, the water gauge side tip was inserted into the brick chimney at a point about 9 ft. above the discharge connection from the fan. The reading there obtained was −·5, the fan having the assistance of the chimney to this extent.

Thus the real pressure head produced by the fan was − 3 ·15 + ·5 + ·5 + ·15 = −2 in. of water, and the h.p. in the gases became $\frac{2 + 100{,}000}{6{,}352} = 31{\cdot}5$, and the mechanical efficiency $\frac{31{\cdot}5}{65} = 48{\cdot}5$ (approx.), which differs considerably from the efficiency previously attributed to the fan.

*(To be continued.)*

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**The New Canadian Tariff.**

For the benefit of those who are not familiar with the new Canadian tariff, the items may be here conveniently enumerated.

British iron and steel goods are free of duty.

Rolled iron or steel and cast steel, in bars, bands, hoop, scroll, strip, sheet, or plate, of any size, thickness, or width, galvanised or coated with any material or not, and steel blanks for the manufacture of milling cutters, when of greater value than 3½ cents per pound.

Rolled iron or steel sheets and strips, polished or not, number 14 gauge and thinner, not otherwise provided for; Canada plates, Russian iron, terne plates, and rolled sheets of iron or steel coated with zinc, spelter, or other metal, of all widths or thicknesses, not otherwise provided for; and rolled iron or steel hoop, band, scroll or strip, number 14 gauge and thinner, galvanised or coated with other metal or not, not otherwise provided for.

Seamless steel tubing, valued at not less than 3½ cents per pound, rolled or drawn; square tubing of iron or steel, adapted for use in the manufacture of agricultural implements; steel balls, adapted for use on bearings of machinery and vehicles; wire and crucible cast steel, valued at not less than 6 cents per pound.

# Superheated Steam in Reference to the Design of Engines.

THE value of superheated steam and the difficulties encountered in the installation of superheaters in stationary steam plants can be understood more readily by indicating, in a brief way, the difference between superheated and saturated steam.

Saturated steam is steam generated in the steam or water space of the boiler, from which in such condition with certain tensions no heat can be abstracted without a percentage of condensation.

Superheated steam is a gas which can be expanded to its saturation temperature without being liquified.

Loss of heat from the pipes in the boiler to the steam engine itself is unavoidable, and therefore a certain part of the saturated steam will condense in those places. This condensation will be in proportion to the moisture contained in the steam. The condensed steam not only does no work, but acts as a hindrance in the steam cylinder. On the other hand, if the steam is superheated, every particle of water contained in the wet steam will be evaporated.

By superheating the steam 200° F. above its temperature, its volume increases owing to pressure about 25 per cent., which augmentation not alone gives more steam, but also reduces the influence of clearance in the cylinder, because superheated steam is more elastic than saturated steam.

Wilhelm Schmidt, the well-known German engineer, has found the best way for the production of this highly superheated steam, and he was the first to design and build engines adapted for its use. The hope cherished by Schmidt with the introduction of superheated steam was that by means of it the degree of efficiency of the "Carnot" process in the engine could be raised, but in the course of his experiments, it was shown that the practical value of superheated steam rested on the fact only that condensation in the cylinder could be eliminated. It seems that these experiments were not carried on far enough, because according to Garbe* later tests made by other authorities mentioned elsewhere in this article established quite an economy of heat units with the use of superheated steam, which is expressed in the following diagram:

At any rate, highly superheated steam having a temperature of from 575° to 625° F. should be used to secure the benefit of steam and coal saving, but this can be accomplished only when the steam is designed for the high temperatures of such steam, and it will therefore be necessary to remodel our present engines.

Before going into the details of such changes, the writer submits three tables

* "The Locomotives of the Present," 1906, p. 223.

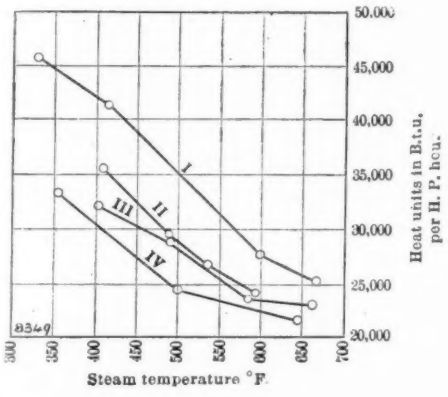


FIG. I.

| Engine Type. | Cylinder Diameter (inches). | Stroke (inches). | R.p.m. | Mean Indicated H.P. | Tests made by | Tests carried out with |
|---|---|---|---|---|---|---|
| I. | 7·1 + 7·1 | 11·8 | 175 | 16·5 | Ripper | Same h.p. |
| II. | 12·6 | 13·8 | 210 | 74·4 | Doerfel | Same cut-off. |
| III. | 9·85 | 15·7 | 150 | 41·25 | Seeman | Variable load. |
| IV. | 9·45 | 29·5 | 95 | 39·4 | Gebr. Sulzer | Same i.h.p. |

showing the steam and coal economy of different types of engines, with the application of superheated steam of different temperatures. The results given were compiled by Prof. Hrabak, Prague, Bohemia; and the writer has enlarged upon them by computing the variable cut-offs to maintain the same power output with the same cylinder dimensions. Attention is called to the low economy of fuel saving where a direct superheat from a separately fired superheater is applied.

It is not in the province of this article to discuss superheaters proper, but their principal feature may be mentioned, which is that the superheater should transmit the highest number of heat units per square foot of heating surface per hour for one degree temperature difference.

The "Corliss" valve, which has given satisfactory results in saturated steam practice, cannot be applied for a steam of very high temperature on account of its large wearing surface, which is difficult to lubricate, and which expands by reason of the high heat of the steam so much that it has given serious trouble by sticking.

It is generally conceded that a superheat of from 100° to 120° F.,

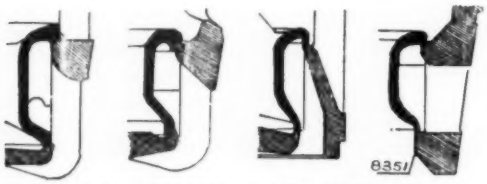


FIG. 2.—TYPES OF DOUBLE SEATED POPPET VALVE.

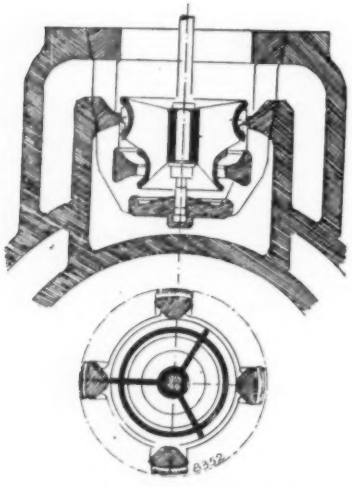


FIG. 3.—4-SEATED POPPET VALVE.

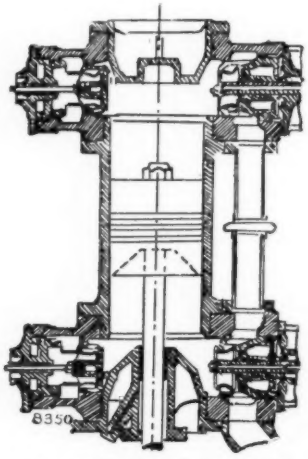


FIG. 4.—CYLINDER WITH FOUR VALVES.

TABLE I.

STEAM AND COAL SAVING IN A TRIPLE EXPANSION ENGINE, CONDENSING, OF 5,000 I.H.P. WITH SUPERHEATED STEAM AT DIFFERENT TEMPERATURES.
Press 14 atm. = 199 lb.; temp. of sat. steam 381 deg. F.; cut-off 4 per cent.; piston speed 16·5 ft. per sec.; automatic cut-off; 4 poppet or piston valves per cyl.

| Kind of Superheat. | Degrees of Superheat. | Temperature of Steam. | Cut-off Constant. I.H.P. Variable. | | | | | | | Cut-off Variable. I.H.P. Constant. | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | I.H.P. | At Engine. | | | At Boiler. | | | I.H.P. | Variation of Cut-off per cent. | At Engine. | | | At Boiler. | | |
| | | | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | Feed-water per i.h.p. hour in lb. | Saving over sat. steam. | | | | Steam consump. per i.h.p. hour in lb. | Saving over sat. steam. | | Feed-water per i.h.p. hour in lb. | Saving over sat. steam. | | |
| | | | | | Steam per cent. | Fuel per cent. | | Feed-water per cent. | Fuel per cent. | | | | Steam per cent. | Fuel per cent. | | Feed water per cent. | Fuel per cent. | |
| | Deg. F. | Deg. F. | | | | | | | | | | | | | | | |
| None ... ... ... | 0 | 381 | 5,000 | 11·82 | — | — | 12·70 | — | — | 5,000 | 4·00 | 11·82 | — | — | 12·70 | — | — | Indirect; superheater in boiler. |
| 75 to 150 deg. F. | | | | | | | | | | | | | | | | | | |
| Low Indirect ... | 144 | 525 | 4,350 | 10·50 | 11·5 | 7·5 | 10·70 | 16 | 12 | 5,000 | 4·85 | 10·90 | 7 | 3·0 | 11·25 | 11·5 | 7·5 | Direct superheater separately fired. |
| Direct ... | 144 | 525 | 4,350 | 10·50 | 11·5 | −3·0 | 10·70 | 16 | 2 | 5,000 | 4·85 | 10·90 | 7 | −8·0 | 11·25 | 11·5 | −2·5 | |
| 150 to 225 deg. F. | | | | | | | | | | | | | | | | | | |
| Medium Indirect | 216 | 597 | 4,150 | 9·81 | 17·0 | 10·0 | 10·03 | 21 | 17 | 5,000 | 5·15 | 10·32 | 13 | 6·0 | 10·52 | 17·5 | 11·0 | |
| Direct ... | 216 | 597 | 4,150 | 9·81 | 17·0 | 0·0 | 10·03 | 21 | 8 | 5,000 | 5·15 | 10·32 | 13 | −4·5 | 10·52 | 17·5 | 1·0 | |
| Double (1) Indirect (2) Direct ... | 216 | 597 | 4,000 | 9·15 | 22·5 | 12·5 | 9·35 | 26 | 19 | 5,000 | 5·40 | 9·60 | 19 | 8·5 | 9·80 | 23·0 | 13·5 | |
| (1) Direct ... (2) Indirect | 216 | 597 | 4,000 | 9·15 | 22·5 | 11·0 | 9·35 | 26 | 17 | 5,000 | 5·50 | 9·60 | 19 | 6·5 | 9·80 | 23·0 | 12·0 | |
| 225 to 290 deg. F. | | | | | | | | | | | | | | | | | | |
| High Indirect ... | 288 | 669 | 4,000 | 9·15 | 22·5 | 13·0 | 9·35 | 26 | 21 | 5,000 | 5·40 | 9·60 | 19 | 9·0 | 9·80 | 23·0 | 14·0 | |
| Direct ... ... | 288 | 669 | 4,000 | 9·15 | 22·5 | 4·0 | 9·35 | 26 | 12 | 5,000 | 5·40 | 9·60 | 19 | −1·0 | 9·80 | 23·0 | 5·0 | |
| Double (1) Indirect (2) Direct ... | 288 | 669 | 3,775 | 8·48 | 28·0 | 16·0 | 8·70 | 31 | 24 | 5,000 | 5·85 | 9·20 | 22 | 9·0 | 9·40 | 26·0 | 14·5 | |
| (1) Direct ... (2) Indirect | 288 | 669 | 3,775 | 8·48 | 28·0 | 14·5 | 8·70 | 31 | 22 | 5,000 | 5·85 | 9·20 | 22 | 7·5 | 9·40 | 26·0 | 13·0 | |
| 290 to 360 deg. F. | | | | | | | | | | | | | | | | | | |
| Very high Indirect | 353 | 734 | 3,775 | 8·48 | 28·0 | 18·0 | 8·70 | 31 | 25 | 5,000 | 5·85 | 9·20 | 22 | 11·5 | 9·40 | 26·0 | 16·5 | |
| Direct ... | 353 | 734 | 3,775 | 8·48 | 28·0 | 8·0 | 8·70 | 31 | 16 | 5,000 | 5·85 | 9·20 | 22 | 1·5 | 9·40 | 26·0 | 7·0 | |

TABLE II.

STEAM AND COAL SAVING IN A COMPOUND ENGINE, CONDENSING OF 250 I.H.P. WITH SUPERHEATED STEAM AT DIFFERENT TEMPERATURES.

Press 10 atm. = 142·24 lb.; temp. of sat. steam 354 deg. F.; cut-off 6 per cent.; piston speed 10 ft. per sec.; automatic cut-off; 4 poppet or piston valves per cyl.

| Kind of Superheat. | Degrees of Superheat. | Temperature of Steam. | Cut-off Constant. I.H.P. Variable. | | | | | | | Cut-off Variable. I.H.P. Constant. | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | I.H.P. | At Engine. | | | At Boiler. | | | I.H.P. | Variation of Cut-off per cent. | At Engine. | | | At Boiler. | | | |
| | | | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | Feed-water per i.h.p. hour lb. | Saving over sat. steam. | | | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | Feed-water per i.h.p. hour lb. | Saving over sat. steam. | | |
| | | | | | Steam per cent. | Fuel per cent. | | Feed-water per cent. | Fuel per cent. | | | | Steam per cent. | Fuel per cent. | | Feed-water per cent. | Fuel per cent. | |
| | Deg. F. | Deg F. | | | | | | | | | | | | | | | | Indirect; superheater in boiler |
| None... ... ... | 0 | 354 | 250 | 14·72 | — | — | 15·73 | — | — | 250 | 6·00 | 14·72 | — | — | 15·73 | — | — | |
| 75 to 150 deg. F. | | | | | | | | | | | | | | | | | | Direct superheater separately fired |
| Low Indirect ... | 130 | 484 | 225 | 12·25 | 15·0 | 11·0 | 12·50 | 21 | 17 | 250 | 6·95 | 12·50 | 15·0 | 11·5 | 12·70 | 20·0 | 16·0 | |
| Direct ... | 130 | 484 | 225 | 12·25 | 15·0 | 1·5 | 12·50 | 21 | 8 | 250 | 6·95 | 12·50 | 15·0 | 1·5 | 12·70 | 20·0 | 7·0 | |
| 150 to 225 deg. F. | | | | | | | | | | | | | | | | | | |
| Medium Indirect ... | 202 | 556 | 215 | 11·60 | 21·0 | 15.0 | 11·81 | 25 | 21 | 250 | 7·50 | 11·75 | 20·0 | 14·0 | 11·98 | 24·5 | 18·5 | |
| Direct ... | 202 | 556 | 215 | 11·60 | 21·0 | 5·5 | 11·81 | 25 | 12 | 250 | 7·50 | 11·75 | 20·0 | 4·5 | 11·98 | 24·5 | 9·5 | |
| Double (1) Indirect (2) Direct ... | 202 | 556 | 205 | 10·70 | 27·5 | 18·0 | 10·93 | 31 | 24 | 250 | 8·00 | 10·85 | 26·0 | 17·0 | 11·09 | 30·0 | 21·0 | |
| (1) Direct ... (2) Indirect | 202 | 556 | 205 | 10·70 | 27·5 | 16·5 | 10·93 | 31 | 23 | 250 | 8·00 | 10·85 | 26·0 | 15·0 | 11·09 | 30·0 | 19·5 | |
| 225 to 290 deg. F. | | | | | | | | | | | | | | | | | | |
| High Indirect ... | 274 | 628 | 205 | 10·70 | 27·5 | 19·0 | 10·93 | 31 | 27 | 250 | 8·00 | 10·85 | 26·0 | 17·5 | 11·09 | 30·0 | 21·5 | |
| Direct ... | 274 | 628 | 205 | 10·70 | 27·5 | 10·0 | 10·93 | 31 | 17 | 250 | 8·00 | 10·85 | 25·0 | 8·5 | 11·09 | 30·0 | 13·0 | |
| Double (1) Indirect (2) Direct ... | 274 | 628 | 198 | 10·27 | 30·0 | 18·5 | 10·50 | 34 | 26 | 250 | 8·50 | 10·51 | 28·5 | 16·0 | 10·75 | 32·0 | 20·5 | |
| (1) Direct ... (2) Indirect | 274 | 628 | 198 | 10·27 | 30·0 | 17·0 | 10·50 | 34 | 25 | 250 | 8·50 | 10·51 | 28·5 | 15·0 | 10·75 | 32·0 | 19·0 | |
| 290 to 360 deg. F. | | | | | | | | | | | | | | | | | | |
| Very high Indirect | 338 | 692 | 198 | 10·27 | 30·0 | 20·5 | 10·50 | 34 | 28 | 250 | 8·50 | 10·51 | 28·5 | 18·5 | 10·75 | 32·0 | 22·5 | |
| Direct ... | 338 | 692 | 198 | 10·27 | 30·0 | 11·5 | 10·50 | 34 | 20 | 250 | 8·50 | 10·51 | 28·5 | 9·0 | 10·75 | 32·0 | 13·5 | |

TABLE III.

STEAM AND COAL SAVING IN A SIMPLE NONCONDENSING ENGINE OF 250 I.H.P. WITH SUPERHEATED STEAM AT DIFFERENT TEMPERATURES.

Press 12 atm. = 177 lb.; temp. of sat. steam 369 deg. F.; cut-off 20 per cent.; piston speed 10 ft. per sec.; slide of piston valve; change of cut-off affected by valve gear.

| Kind of Superheat. | Degrees of Superheat. | Temperature of Steam. | Cut-off Constant. I.H.P. Variable. | | | | | | | | Cut-off Variable. I.H.P. Constant. | | | | | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | I.H.P. | At Engine. | | | At Boiler. | | | | I.H.P. | At Engine. | | | At Boiler. | | | | |
| | | | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | Steam consump. per i.h.p. hour lb. | Saving over sat. steam. | | | |
| | | | | | Steam per cent. | Fuel per cent. | | Feed-water per cent. | Fuel per cent. | | | | Steam per cent. | Fuel per cent. | | Feed-water per cent. | Fuel per cent. | | |
| | Deg. F. | Deg. F. | | | | | | | | | | | | | | | | | |
| None... ... ... | 0 | 369 | 250 | 27·00 | — | — | 29·00 | — | — | | 250 | 2.700 | — | — | 29·00 | — | — | 20·00 | Indirect; superheater in boiler |
| 75 to 150 deg. F. | | | | | | | | | | | | | | | | | | | |
| Low Indirect ... | 103 | 472 | 235 | 21·00 | 22·0 | 18·5 | 21·40 | 27 | 23 | | 250 | 21·05 | 22·0 | 18·5 | 21·47 | 26·0 | 22·5 | 20·88 | Direct superheater separately fired. |
| Direct ... | 103 | 472 | 235 | 21·00 | 22·0 | 10·0 | 21·40 | 27 | 14 | | 250 | 21·05 | 22·0 | 9·5 | 21·47 | 26·0 | 14·0 | 20·85 | |
| 150 to 225 deg. F. | | | | | | | | | | | | | | | | | | | |
| Medium Indirect | 162 | 531 | 230 | 19·85 | 26·5 | 20·5 | 20·10 | 30 | 27 | | 250 | 20·00 | 25·5 | 20·0 | 20·40 | 29·5 | 24·0 | 21·35 | |
| Direct ... | 162 | 531 | 230 | 19·85 | 26·5 | 21·5 | 20·10 | 30 | 19 | | 250 | 20·00 | 25·5 | 11·0 | 20·40 | 29·5 | 15·5 | 21·35 | |
| 225 to 290 deg. F. | | | | | | | | | | | | | | | | | | | |
| High Indirect ... | 234 | 603 | 222 | 18·50 | 31·0 | 23·0 | 18·85 | 35 | 31 | | 250 | 18·75 | 30·5 | 22·0 | 19·13 | 34·0 | 26·0 | 21·75 | |
| Direct ... | 234 | 603 | 222 | 18·50 | 31·0 | 15·0 | 18·85 | 35 | 22 | | 250 | 18·75 | 30·5 | 13·5 | 19.13 | 34·0 | 18·0 | 21·75 | |

with a final temperature of the steam of not more than 475° F. at the valve, is allowable for a "Corliss" valve. Yet the writer knows of one case in which the final temperature was 497° F. This is not high enough, especially in high duty engines, to obtain high economies; therefore, with the use of highly superheated steam as referred to above, it is necessary to replace the "Corliss" valve by double-seated poppet valves for engines of moderate size and slow piston speed, and, for large engines of high piston speeds, by four-seated poppet valves. It is also advisable to apply piston valves. The illustration, Fig. 5, shows the "Schmidt" solid piston valve, which has the interesting feature of being jacketed by superheated steam. The other valve, Fig. 6, used in Belgium mostly, has one solid ring

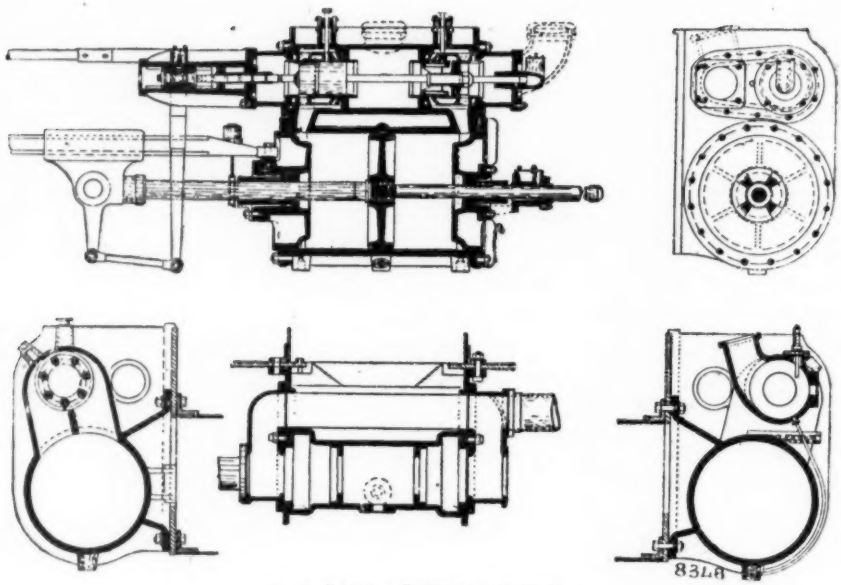

FIG. 5.—"SCHMIDT" SOLID PISTON VALVE.

with several grooves and small holes for the purpose of leading any steam that may leak through from the admission side to the back of the ring, so enabling it to act as a spring, thus giving it closer contact. One or four of either type of valve for one cylinder can attend to the distribution of steam.

It is advantageous to locate the valves in the cylinder heads in order to get a very plain cylinder in the form of a straight pipe. The cylinder can be made very plain as a steam jacket is not necessary for the high-pressure cylinder, while for the low-pressure, a jacket may be applied. The material of the cylinder should be distributed uniformly to prevent warping due to the high temperatures.

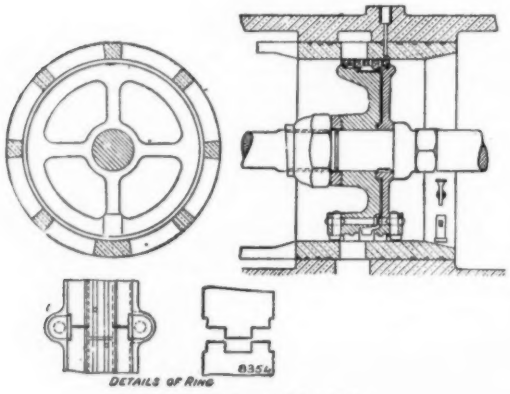


FIG 6.--BELGIAN PISTON VALVE.

For horizontal tandem type engines the low pressure cylinder should, whenever possible, be located on the frame and the high-pressure cylinder in the rear, which arrangement will at the same time reduce any heating in the cross head guides.

The tandem type is recommended on account of being

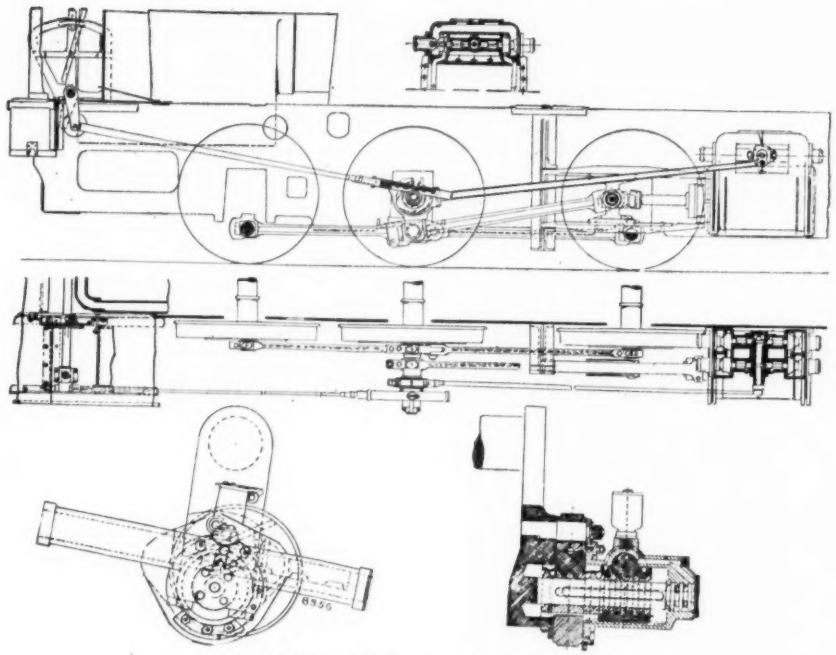

FIG. 7.—"LENTZ" VALVES AND GEAR FOR LOCOMOTIVES.

able to work the engine with high piston speed, which means low first cost of the engine.

Although it is generally understood that poppet valve engines can run only at about 120 to 150 revolutions per minute, the latest types on the Continent are designed for 230 to 240 revolutions per minute. The writer so far has not been able to corroborate the latter statement.

If valve castings are cast on the cylinder, it should be done in a very plain manner, but no steam channels should be cast on in connection therewith. Each valve casting should be provided with a flange to make pipe connection for admission as well as exhaust steam.

The piston should have at least three rings of good width.

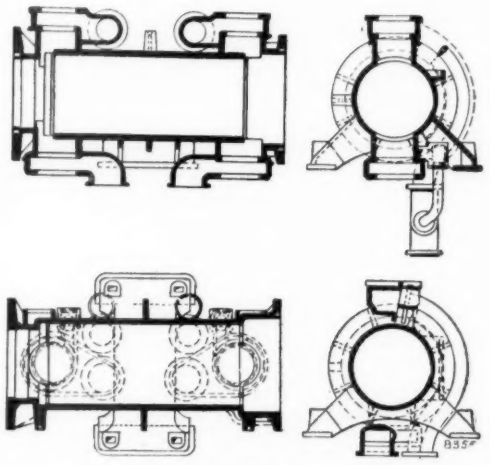

FIG. 8.—CYLINDER FOR HIGHLY SUPERHEATED STEAM.

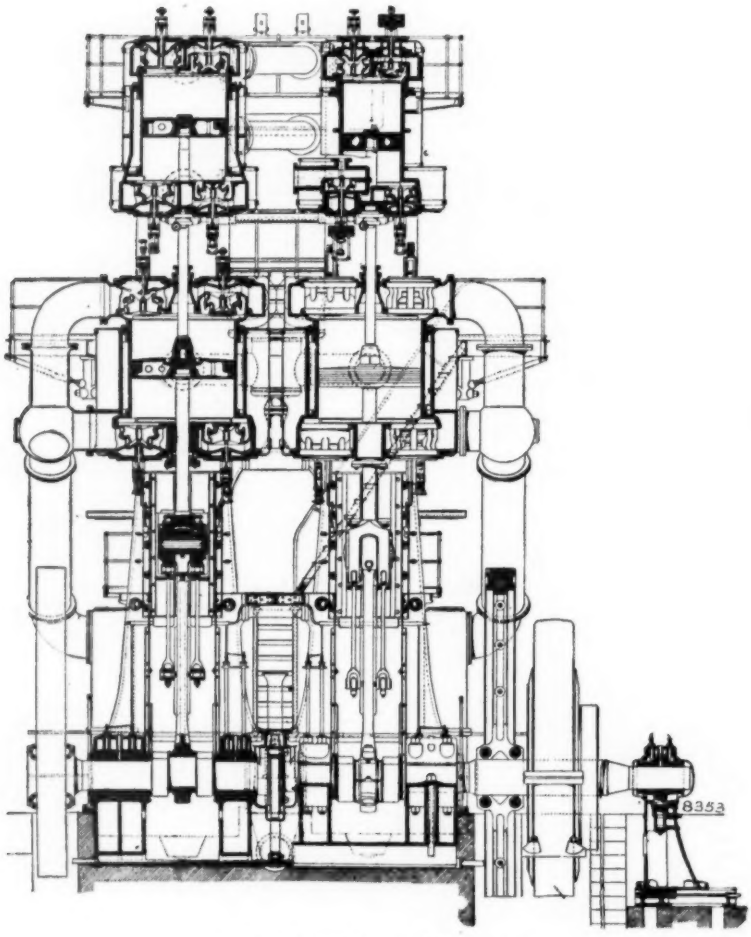


FIG. 9.—3,000 H.P. ENGINE BY SULZER BROS.

For horizontal engines it should be guided outside of the cylinder by the cross head and an extra liberal bearing for the extended piston rod, so that the piston body will not ride on the cylinder wall.

The piston should be lubricated directly and not by mixing the oil with the admission steam.

The packing of the piston rod should consist of metallic rings of a composition adapted to stand the high temperature. A composition of 80 per cent. antimony and 20 per cent. lead has given good results. At the same time the stuffing boxes should be arranged so as to offer plenty of cooling surface to the outside air in order to reduce the temperature.

The cylinder dimensions of the

saturated steam engine are based upon an economical cut-off, and the reduction of this cut-off is limited by the increasing condensation which takes place when the cut-off is decreased beyond a certain minimum. To improve this feature the compound triple and quadruple expansion engines have been introduced; into which, on account of the smaller temperature differences between the admission and the exhaust steam in the different cylinders, condensation has been decreased materially.

In an engine for superheated steam, the degree of expansion can be brought to a higher state of perfection, because it was only a question of superheating the admission steam high enough to eliminate condensation entirely. Therefore the cut-off should be reduced, but the cylinder dimensions should be enlarged in proportion so as to be equivalent to the saturated steam engine.

On existing engines the speed should be increased if it is mechanically possible. Although this change calls for higher steam velocities in the steam channels and valves it must be borne in mind that superheated steam can attain velocities from 40 per cent. to 60 per cent. greater than that of saturated steam without showing a throttling line of expansion on an indicated diagram.

[M. E. Toltz, in the *Proceedings American Society of Mechanical Engineers*, Vol. 29, No. 1.]

# IRON, STEEL, AND THE FOUNDRY.

*Conducted by PERCY LONGMUIR.*

## PAPERS READ AT THE AUTUMN MEETING OF THE IRON AND STEEL INSTITUTE.

**The Austrian Iron Industry.**—Mr. Kestranek gives an admirable review of the Austrian iron industry during the last twenty-five years, and incidentally touches on economic topics which, though somewhat beyond the legitimate scope of the Institute, are none the less of interest to iron producers in this country. Twenty-five years ago Austria-Hungary held the sixth position among iron producing countries, and concurrently with the universal advance still occupies the same relative position. In this interval Great Britain has lost her leading position and has been surpassed by the United States and latterly by Germany.

Austria-Hungary possesses several rich deposits of iron ore, as, for instance, the celebrated Styrian Ore Mountain. Further extensive smelting of these ores is retarded by the scarcity of fuel, and for this reason the monarchy at the present time is one of those countries which export iron ore. The development of the iron industry of any country depends more on the richness of its fuel resources than on an abundance of ore. Thus countries rich in ore and poor in fuel, as Sweden and Spain, export the greater part of their output of ores to countries rich in fuel; and are in proportion to their wealth of ore only small producers of pig iron. Countries such as Great Britain and Germany, which import considerable quantities of ore, occupy leading positions. It is unnecessary to mention the happy United States, which rejoices in the possession of abundant supplies of ore and coking coal, and for this reason takes *the* leading

position. The quantity and quality of the iron ores are as important a factor in commercial competition in the iron industry of a country as are the number and condition of the soldiers of an army; while the fuel resources are for the iron industry what the generalship and armament are for such an army. Under otherwise equal conditions superiority in training and equipment of an army are more efficacious at the present time than mere weight of numbers. It therefore appears that the quality and quantity of fuel available are more decisive factors in the industrial development of the iron trade of a country than wealth of ores. In developing this comparison the author mentions that the conditions of two combatants are influenced by other circumstances: for example, the existence of ramparts—in other words, protective duties; by the natural resources and financial wealth of the two competitors which in this case is the demand of the home market. Finally, the fortune of war depends on whether the forces are kept free from disease, these diseases mostly of a contagious character, taking the form of strikes and organised efforts to retard production. As an example, the author holds the opinion that the development of the British iron trade would have been far more successful if the introduction of technical improvements had not been hindered by the action of trade organisations.

After giving comparative statistics of the population of the chief iron producing countries and the yearly iron consumption per head, the author passes on to a similar consideration of fuel and fuel supplies. The results tend to show that the measure of the industrial condition of a country depends less on the production of iron than on the production and consumption of fuel. In this respect it is worth noting that throughout the whole of Austria there are no blast furnaces which have both ore and coke on the spot. If, in spite of this want of mineral fuel, in spite of the circumstances conspiring to increase the cost of production, and that either the fuel or the ore can only be brought to the producing centres by costly routes, and in spite of the limited demand of an extensive portion of the empire, the Austrian iron industry has been able during the last twenty-five years to keep pace relatively with other iron producing countries; this can be attributed to three reasons: firstly, to the sufficiency of the protective import duties, behind the wall of which a prosperous development of the iron industry has been possible; secondly, the association of the iron works into a syndicate, whereby ruinous competition has been prevented; and thirdly, the concentration of the smaller works into large units. By the two last mentioned means the adoption of more economical methods of working has been rendered possible.

In the foregoing we have endeavoured to give in the author's own words some of the more general features of a paper distinctly different from the usual type submitted to the Institute. Other features of the paper lie in its technical side, and from these we gather that Austria does not lag in the adoption of modern methods. Thus the "Witkowitz" blast furnaces have a daily production up to 450 tons, and are equipped with modern appliances and automatic charging apparatus. The Königshof Iron Works have blast furnace gas engines of more than 6,000 h.p., driving not only the blowing engines but also a sheet rolling mill. In other works phosphoric slags are converted into artificial manure, and blast furnace slags are manufactured into slag bricks and slag cement. The Kjellin, Keller and Héroult electric steel processes are in use and electricity is extensively adopted for general purposes.

**The Determination of the Total Quantity of Blast Furnace Gas for a given make and its Calorific Value.**—Under this heading Professor Ehrenwerth gives a short technical paper of high value to the blast furnace manager or chemist. The increasing importance of waste gases renders a closer control necessary in their disposal, and for this purpose an easy means of determining the quantity available at any time is desirable. The data required are: (1.) The weight of carbon contained in the gases corresponding to any particular unit make of weight, say 100 kilogrammes; (2.) An analysis of the gas expressing the constitutents usually determined, in percentage volume. The first of these quantities, the carbon in the gases, $C_c$ corresponds to the total carbon ($C\Sigma$) in the materials charged into the furnace, *i.e.*, carbon in fuel and that in carbon dioxide contained in limestone flux or uncalcined carbonate ores, diminished by the amount ($C_1$) absorbed in carbonising the metal, and that ($C_2$) in unconsumed fuel carried away by the gas and intercepted in the dust catcher, or

$$C_c = C\Sigma - (C_1 + C_2).$$

The analysis of the gas should include determinations of carbonic acid and oxide; light and heavy hydrocarbons and nitrogen, together with hydrogen on account of its high specific volume, although the weight is

usually unimportant. The calculation depends on the simple proposition that the ratio of the volume of gas produced per unit of make to that of the analysis (100 volumes) is the same as that of the carbon contents of these quantities.

Supposing the analysis to show the constituents and their corresponding volumes to be—

$$a\mathrm{CO_2} + b\mathrm{CO} + c\mathrm{CH_4} + d\mathrm{C_2H_4} + e\mathrm{H} + f\mathrm{N} = 100.$$

the carbon contained per 100 cubic metres in kilogrammes will be—

$$\tfrac{3}{1.1}\,1{\cdot}978a + \tfrac{3}{4}\,1{\cdot}252b + \tfrac{3}{4}\,0{\cdot}559c + \tfrac{6}{7}\,1{\cdot}16d. = \mathrm{C}_g$$
$$= 0{\cdot}539a + 0{\cdot}537b + 0{\cdot}419c + 0{\cdot}994d. \quad = \mathrm{C}_g$$

Or, in round numbers—

$$\mathrm{C}_g = 0{\cdot}54\,(a+b) + 0{\cdot}42c + 1{\cdot}00d.$$

The corresponding volumes of the different constituents per 100 units of make will then be found from the following proportions:—

For $\mathrm{CO_2}$ in met.ª. $\mathrm{C}_G : \mathrm{C}_g = x\,\mathrm{CO_2}$ :

$$a\ x\mathrm{CO_2} = \frac{\mathrm{C}_G}{\mathrm{C}_g}a.$$

„ CO „ $\mathrm{C}_g : \mathrm{C}_g = x\,\mathrm{CO}$ :

$$b\ x\mathrm{CO} = \frac{\mathrm{C}_G}{\mathrm{C}_g}b,$$

and so on for the remaining constituents.

Or, in general—

Volume of gas in cubic metre per 100 units make

$$= \frac{\mathrm{C}_G}{\mathrm{C}_g}(a + b + c \ldots)$$

of the volumes per cent. by analysis.

In the same manner the total quantity of gas is given by—

$$\mathrm{G} = \frac{\mathrm{C}_G}{\mathrm{C}_g}\,100.$$

The results found by calculation are for the gas in the dried state, and require to be corrected for the water vapour derived from damp materials in the charge if necessary; and the volumes found are expressed at normal atmospheric pressure and a temperature of 0° C. For any other pressure, $b_1$ or temperature $t$, they become—

$$\mathrm{G}\ b_1 = \mathrm{G}_0 \quad {}^{\circ}_{760\text{ m.}} \cdot \frac{760}{b_1}(1 \times \alpha t).$$

The calorific value per cubic metre at 8° C. and 760 millimetres is—

$$\mathrm{W} = 30{\cdot}63\,\mathrm{CO} + 86{\cdot}00\,\mathrm{CH_4} + 140.\ \mathrm{C_2H_4} + 26.2\mathrm{H}\ \text{calories},$$

the gas being supposed to be free from water.

The following example illustrates the use of the method. A blast-furnace making white forge iron, with charcoal, from spathic ores (two-thirds calcined and one-third raw) consumed 74 kilogrammes of fuel per 100 kilogrammes of metal produced. What is the total volume of gas?

The charcoal contained

C, 85.1; $\mathrm{CO_2}$, 3.26; CO, 1.36; $\mathrm{CH_4}$ 0.7 per cent.;

or carbon in 74 kilogrammes

| | Kilogrammes. |
|---|---|
| | $62.97 + 0.66 + 0.43 + 0.38 = 64.44$ |
| Carbon of $\mathrm{CO_2}$ in raw ore ... ... | 4.54 |
| Total carbon in materials charged | $\mathrm{C}\Sigma$ 68.98 |
| Carbon in metal ... ... ... ... | 3.12 |
| Total carbon in gases ... ... | $\mathrm{C}_G$ 65.86 |

The gases contained—

$\mathrm{CO_2}$, 15.3; CO, 25.6; $\mathrm{CH_4}$, 0.7; H, 1.3; N, 57.1 volumes per cent.

containing carbon $22.0 + 0.29 = 22.29$ kilogrammes $= \mathrm{C}_g$

$\frac{65.86}{22.29}\,100 = 295.47$ cubic metres per 100 kilogrammes, or 2954.7 cubic metres = 104,350 cubic feet per ton.

The calorific value is—

$$30.63.25.6 + 86.0.7 + 26.2.1.3$$
$$784 + 60.2 + 34.1 = 878 \text{ calories per cubic metre, or } 98.4 \text{ British thermal units per cubic foot.}$$

**The Erzberg of Eisenerz.**—Professor Bauerman gives, in a noteworthy paper, a most readable description of one of the most remarkable ore deposits known. Accompanying the paper is an admirable sketch map showing the geological structure of the Eisenerz region. The Ore Mountain of Eisenerz is the largest of a series of mineral deposits associated with the Palæozoic rocks of the Eastern Alps on their northern slope, which extends from the Tyrol on the west to the margin of the Vienna basin in the east, a distance of nearly 200 miles. These deposits, although following one general direction, are irregularly distributed and vary as to size and minerals contained. Some of them have been worked as copper mines, and at Kallwang, Radmer and Johnsbach, copper mining was carried on from the year 1546 to the middle of the nineteenth century. To-day only iron ore and magnesite deposits are of importance, and among the former the Erzberg takes a prominent position. After describing in detail the structure of the deposits, Professor Bauerman passes on to an examination of the ore, and at the

present time an average composition of the whole output is :—

| | Raw Ore. Per cent. | Calcined Ore. Per cent. |
|---|---|---|
| Ferric oxide ... | 19·50 = Fe 13·65 | 71·18 = Fe 49·83 |
| Ferrous oxide ... | 32·25 = Fe 25·08 | 1·23 = Fe 0·85 |
| | 38·73 | 50·68 |
| Manganic oxide ... | 3·50 = Mn 3·245 | 4·29 = Mn. 3·00 |
| Lime ... ... | 5·92 | 6·19 |
| Magnesia ... ... | 4·06 | 4·14 |
| Carbon dioxide ... | 27·62 | 2·64 |
| Water ... .. | 0·84 | 0·14 |
| Silica ... ... | 4·08 | 8·19 |
| Alumina ... ... | 1·26 | 1·61 |
| $P_2O_5$ ... ... | 0·034 = P 0·015 | 0·059 = P 0·025 |
| $SO_3$ ... ... | 0·202 = S 0·079 | 0·432 = S 0·169 |

Until past the first half of the nineteenth century the Erzberg ore was smelted with charcoal, but growing scarcity has led to the abandonment of this fuel. Out of forty-five charcoal furnaces existing in 1882 only four are now intermittently at work. The product of these furnaces is used by crucible steel makers. The chief coke smelting operations are conducted at Donawitz and Eisenerz. The coke used is mostly Westphalian, and the consumption is about 18 cwts. per ton. The daily make is about 300 tons with 16·8 cwts. of slag per ton. The range in composition of the metal is :—

| Carbon | Manganese | Silicon | Sulphur | Phosphorus |
|---|---|---|---|---|
| 3·0 to 3·8 | 2·2 to 2·8 | 0·5 to 0·7 | 0·04 to 0·08 | 0·05 to 0·10 |

**Steel and Meteoric Iron.**—Vienna is fortunate in possessing an unrivalled collection of meteorites, and members of the Institute are even more fortunate in having a description of these meteorites from the able pen of Professor Berwerth. It would appear a far cry from steel to meteoric iron, but researches have shown that meteoric irons may in their essentials be included in the category of steel; the difference between the two being that while artificially produced steels are mainly iron carbon alloys, meteoric steel is an iron nickel alloy with meteoric carbon. Owing to the importance of carbon steels they have received special attention and research, whilst nickel steels, in which the student of meteoric mineralogy is chiefly interested, have received less attention. However, from ordinary steels important results have been obtained. Thus Arnold & McWilliam have shown that in steel of 0·30 per cent. carbon the Widmannstätten figures, previously considered as essentially characteristic of meteoric origin, can be formed by alternations of ferrite and pearlite. These figures disappear when the metal is heated to 950° C. and slowly cooled, thus showing a coincidence in structure with octahedral meteoric iron, investigated by the author previous to the publication of Arnold & McWilliam. From the results of the newer metallographic work which bear directly on problems arising in the study of meteorites, and the advancing knowledge of the structure of metallic alloys, we may hope that the structure of the meteorite may ultimately be reproduced from the steel melters' crucible. The combination of hardness with toughness which renders the cutting of meteoric irons a matter of difficulty is in the main due to their reticular structure. According to the author's views, the artificial reproduction of such a structure would be of value in increasing the strength and durability of steel in much the same way that an intimately fibrous mixture makes a rock of stronger structure than where the same minerals have a granular structure.

**The Hardening of Steel.**—M. Demozay records a series of admirable experiments under this heading. The samples treated were of special nickel chrome steel, but as the analysis of the steel is not given, the work naturally loses much of its interest. However, from preliminary experiments the following conclusions are reached :—

1. That after the brief perturbation, to which the name of transformation has been given, fresh molecular groupings, having a direct relation to the mode of quenching, constantly occur in the interior of the metal.

2. That these groupings do not take place instantly, but that they occur with greater facility in proportion as the temperature is higher and that the period of heating is longer.

3. That the particular groupings which it is desirable to promote appear to be those which correspond to the state of equilibrium bordering on the upper limit of the transformation.

4. That on the rapid cooling which supervenes on heating, and when the inverse transformation has taken place, it is these groupings which remain, so to speak, stereotyped in their former arrangement, and confer the distinctive character of hardening.

5. That the maximum rate of cooling should occur chiefly at the commencement of the transformation on cooling, when the whole of these groupings have taken place.

Further experiments as to the influence of the size of the sample, energy of the

quenching bath, &c., are recorded and well illustrated by a series of curves.

**The Structure of Hardened Steels.**—Mr. Longmuir states the ultimate test of a hardened steel to lie in its working life as a tool. This feature is not generally recognised in the literature of hardening, and as a result practical men distrust researches on hardening when founded on results deduced from microscopical examination. So much is this the case that the microscope is regarded by many competent workers as having failed to be of service in the case of hardened steel. Actually no metallographical investigation yet published has been of service as a guide to the thermal treatment of high speed steel, and with few exceptions comparatively little information of value has been given on the hardening or tempering of carbon steels. This does not necessarily condemn the microscope as a practical aid in the study of hardening, but rather emphasises the difficulties of interpretation and also the fact that many scientific workers are unfamiliar with the practical aspects of the work. The divergence between theory and practice has led to controversy, but whilst ignoring controversial questions the author examines some sources of variation. In actual hardening practice one of the first essentials is that of a suitable content of carbon in the steel, and the usual range is from 0·5 to 1·5 per cent. Given a suitable carbon for the particular purpose of the tool, the next feature of note lies in the regular and uniform results attained in practice. Attention is also drawn to the fact that the majority of tools are tempered after hardening. From the examination of a large number of commercially hardened steels the author finds the constituents to be, according to the amount of carbon present, ferrite and hardenite; hardenite; or hardenite and cementite. The particular arrangement of structure varies according to the extent of the tempering given.

An examination of a series of steels purposely or accidentally spoilt in hardening showed many erratic structures and an infinite number of patterns. Characteristic martensitic, austenitic and troostitic patterns were freely noted. The majority of these steels were flint hard, but otherwise were useless for cutting or resisting abrasion. The results obtained from these two series of steels lead to the conclusion that, as far as structure is concerned, the characteristic feature of a correctly hardened steel is an absence of definite or pronounced structure, whereas the leading trait of a spoilt steel is the presence of a definitely sharp structure.

A series of experimental results are given, which show that the ideal structure is produced only in a certain range of quenching temperature, which varies according to the composition of the steel and the contour of the piece to be hardened.

# THE ENGINEERING PRESS.

**In this section is presented every month a list of the more important articles appearing in the Engineering Press and of the leading papers read before the various engineering institutions. Full names, addresses, and published prices of the publications indexed are printed each half-year in the volume index.**

## Civil Engineering.

The Fastnet Rock Lighthouse. *Engineer*, *13th September*, 1907.

Masonry Dams. By T. G. Bocking. *Engineer*, *27th September*, 1907.

An Application of Rolled Sectional Steel to Bridge Floors. By C. Gribble. *Railway Gazette*, *27th September*, 1907.

Continuous Girders. *Engineer*, *27th September*, 1907.

The Quebec Bridge. *Engineering*, *13th*, *20th* and *27th September*, 1907.

A Unit Table for Talbots' Spiral. *Engineering Record*, *7th September*, 1907.

The Selby Hill Street Railway Tunnel, St. Paul, Minnesota. *Engineering Record*, *21st September*, 1907.

The Quebec Bridge Disaster. The Fall of the Quebec Bridge. *Engineering*, 13*th September*, 1907.

Roofs, IV. *Railway Engineer*, *October*, 1907.

Completion of the Cross River Dam, Croton Water Works System. *Engineering Record*, 14*th September*, 1907.

Modern Development of British Fishery Harbours. By H. C. M. Austen. *Engineering*, 20*th September*, 1907.

The Collapse of the Quebec Bridge. *Engineering*, 20*th September*, 1907.

The Bracing of Trenches and Tunnels, with Practical Formulas for Earth Pressures. By J. C. Meem. *Proceedings American Society Civil Engineers*, *August*, 1907.

The Proportioning of Steel Railway Bridge Members. *Engineering News*, 19*th September*, 1907.

The Quebec Bridge. *Engineering News*, 12*th September*, 1907.

Fall of the Quebec Cantilever Bridge. *Engineering News*, 5*th September*, 1907.

The Erection of the South Cantilever Arm of the Quebec Bridge. *Engineering Record*, 28*th September*, 1907.

Sound Concrete Construction. By J. T. Noble Anderson, M.Inst.C.E. *Engineer*, 4*th October*, 1907.

The Panama Canal. By W. H. Hunter, M.Inst. C.E. *Times Engineering Supplement*, 9*th October*, 1907.

## Building.

Reinforced Concrete Towers. By D. W. Krellwitz. *Proceedings American Society Civil Engineers*, *August*, 1907.

Engine Foundations. *Practical Engineering*, 27*th September*, 1907.

## Heating and Ventilation.

The Heating and Ventilation of Machine Shops. By C. L. Hubbard. *Machinery*, *September*, 1907.

## Materials and Measurements.

Notes on some Physical Characteristics of Cast-Iron. *Proceedings Engineers' Club of Philadelphia*, *July*, 1907.

Effect of Steam Curing on the Crushing Strength of Concrete. *Engineering News*, 5*th September*, 1907.

The Corrosion of Iron, &c., Rusting. *Engineering News*, 26*th October*, 1907.

## Boilers, Furnaces, and Fuel.

Modern Power Gas Producer Practice and Applications. By Horace Allen. *Practical Engineer*, 13*th* and 27*th September*, 1907.

Notes on the Use of Producer Gas for Power Purposes. By J. R. Ribbins. *Proceedings Engineers' Club, Philadelphia*, *July*, 1907.

Steam Boilers (*continued*). *Practical Engineer*, 20*th September*, 1907.

## Engines and Motors.

Experiences with Gas Engine Breakdowns *Journal Gas Lighting*, &c., 17*th September*, 1907.

Engine Design Adapted for the Use of Superheated Steam. By Mr. M. E. R. Voltz *Proceedings American Society Mechanical Engineers*, *September*, 1907.

Indicator Practice. Types of Indicators and Reducing Gears. Methods of Taking Diagrams. *Engineer, Chicago*, 16*th September*, 1907.

Thermal and Power Horses in Internal Combustion Engines, I. *Engineering*, 4*th October*, 1907.

Parsons Type Steam Turbines. Chas. H. Naylor. *Engineer*, 4*th October*, 1907.

Pressure Gauges. *Engineer*, 4*th October*, 1907.

## Hydraulics and Compressed Air.

Hydraulic Formulæ. By H. Jacoby. *School of Mines Quarterly*, *July*, 1907.

High Lift Turbine Pumps. *Electrical Review*, 4*th October*, 1907.

Experiments with Submerged Tubes, 4 ft. square. *Engineering Record*, 28*th September*, 1907.

## Shop Equipment and Practice.

Machine Tool Design. By Prof. T. Nicolson and Mr. Dempster Smith, XLI. *Engineer*, 13*th September*, 1907.

Tests of Emery Grinding-Wheels. *Engineering*, 13*th September*, 1907.

Reamers, II. By Erick Oberg. *Machinery*, *September*, 1907.

## Miscellaneous Mechanical Subjects.

Practical Theories of Mechanical Engineering, IX. *Mechanical World*, 4*th October*, 1907.

Driving a Foundry Fan. By W. J. May. *Practical Engineer*, 4*th October*, 1907.

The Design of Rectangular Steel Tanks. By E. G. Beck. *Mechanical World*, 27*th September*, 1907.

Power Transmission by Friction Driving. By Prof. W. F. M. Goss. *Proceedings American Society Mechanical Engineers*, *September*, 1907.

Design of Condensing Plant, XXVI. *Mechanical World*, 20*th September*, 1907.

Notes on Mill Power Plant, XIV. *Mechanical World*, 20*th September*, 1907.

Notes on Belting. By Wm. O. Webber. *Engineer, Chicago*, 16*th September*, 1907.

Pull of Belts. By V. C. Wynne. *Engineer, Chicago*, 16*th September*, 1907.

The Capacity of Cooling Towers. *Engineer*, 13*th September*, 1907.

## Locomotive and Railway Engineering.

Manufacture of Boiler Tubes. *Railway and Engineering Review*, 7*th September*, 1907.

Ash Handling Plant. *American Engineer and Railroad Journal*, *September*, 1907.

Mallet Articulated Compound Locomotive, 0-8-8-0 Type, Erie Railroad. *American Engineer and Railroad Journal, September*, 1907.

Co-operation between the Operating and Mechanical Departments. Suggestions for Decreasing the Cost of Locomotive Repairs. By A. W. Wheatley. *American Engineer and Railroad Journal, September*, 1907.

Locomotive from Cleaning to Driving, IX. By Jno. Williams and Jas. T. Hodgson. *Railway Engineer, October*, 1907.

The Railways of Australia. *Le Genie Civil (continued)*, 14*th* and 21*st September*, 1907.

Eliminating Smoke with Locomotives Burning Soft Coal. *Engineering News*, 19*th September*, 1907.

Locomotive Piston Valves. By H. R. Stafford (*continued*). *Mechanical World*, 20*th September*, 1907.

Engineering Features of the Western Pacific Railway. *Engineering Record*, 28*th September*, 1907.

Dynamometer Car, N.E.R. *Engineer*, 4*th October*, 1907.

First-class Dining Car, L. & Y. Railway. *Railway Gazette*, 4*th October*, 1907.

## Motor Engineering.

Malleable Castings for Motor Cars, II. By P. J. Giron. *Mechanical World*, 13*th September*, 1907.

The Dentan Carburettor. *Automotor Journal*, 14*th September*, 1907.

Commercial Motor Vehicles. By E. Shrapnell Smith. *Royal Automobile Club Journal*, 3*rd October*, 1907.

The 20 h.-p. Valveless Car. *Automotor Journal*, 5*th October*, 1907.

The Motor Car, from an Engineer's Point of View. By G. H. Baillie. *Automotor Journal*, 28*th September*, 1907.

Hints on the use of Benzol. *Autocar*, 28*th September*, 1907.

A Traction Engine with Derrick and Shovel Attachment. *Engineering News*, 19*th September*, 1907.

A New Variable Gear. *Autocar*, 21*st September*, 1907.

The Dentan Carburetter. A Combination of Porous Pot and Barometer. *Autocar*, 21*st September*, 1907.

Gasoline Locomotives and Motor Cars. *Engineering News*. 5*th September*, 1907.

The Manufacture of Connecting Rods. *La Locomotion Automobile*, 14*th September*, 1907.

## Electric Lighting.

The Helion Lamp. By W. G. Clark and H. C Parker. *School of Mines Quarterly, July*, 1907.

The Economy of the Tungsten Lamp. *Electrical World*, 7*th September*, 1907.

The Engineering of Show-Window Illumination. *Electrical World*, 7*th September*, 1907.

Factory Lighting. *Engineering Record*, 21*st September*, 1907.

Recent Advances in Artificial Lighting. Arc and Vacuum Tube Electric Lamps. *Engineering News*, 12*th September*, 1907.

An Improved Mercury Vapour Lamp. *Electrical Engineering*, 10*th October*, 1907.

## Electrical Generation and Transmission.

The Hydro-Electric Development of the Great Northern Power Co., I. *Engineering Record*, 7*th September*, 1907.

Abnormal Primary Current and Second Voltage on Placing a Transformer in Circuit. *Electrical World, New York*, 14*th September*, 1907.

A Year's Operation of the Highest Working Voltage in the World. By F. E. Greenman. *Electrical World, New York*, 14*th September*, 1907.

Aluminium Cables for the Loch Leven Power Company. *Electrical Engineer*, 27*th September*, 1907.

The McCall Terry Hydro-Electric Power Plant on the Susquehanna River. *Engineering News*, 12*th September*, 1907.

High Voltage Direct Current and Alternating Current Systems for Inter-urban Railways. By W. J. Davis. *Proceedings American Institute Electrical Engineers, August*, 1907.

Electrical Equipment at the Mansfield Copper Mines. *Electrical Engineering*, 10*th October*, 1907.

## Electric Traction.

Report of the German Street and Interurban Railway Association's Committee on Standardisation. *Street Railway Journal*, 7*th* and 14*th September*, 1907.

The 50,000 Volt-Line of the Taylor's Falls—Minneapolis Power Transmission. *Electrical World*, 7*th September*, 1907.

Electricity for Cement Plants. *Engineering Record*, 21*st September*, 1907.

Electric Traction on Railways, IV. By P Dawson. *Electrician*, 13*th September*, 1907.

New York Meeting of the Standardisation Committee of the American Street and Interurban Railway Engineering Association. *Street Railway Journal*, 21*st September*, 1907.

Middletown-Berlin Electrification of the New York, New Haven, and Hartford Railroad. *Street Railway Journal*, 21*st September*, 1907.

The Accident to Sydney Tramway Feeders. *Electrical Review*, 4*th October*, 1907.

Insulated Steel Ties on the Pittsburg and Lake Erie Railroad. *Railway and Engineering Review*, 21*st September*, 1907.

Distribution of Current to Trains on Electric Railways. *Railway Engineer, October*, 1907.

Rail Corrugation. By A. L. C. Tell. *Electrical Engineer*, 4*th October*, 1907.

Contact Resistance in connection with Rail Bonding. *Street Railway Journal*, 14*th September*, 1907.

Municipal Tramways Association. *Electrical Engineer*, 27*th September*, 1907.

The Installation of Electric Traction on the New York Terminal Section of the New Haven Railroad. *Engineering News, 5th September, 1907.*

Some Facts and Problems bearing on Electric Trunk-Line Operation. *Proceedings American Institute Electrical Engineers, August, 1907.*

Railway Electrification. By P. Dawson. *Times Engineering Supplement, 9th October, 1907.*

Electric Locomotives, Pennsylvania Railroad. *Railway Gazette, 4th October, 1907.*

Combination D.C. and Single-Phase Equipment for the Vienna-Baden Railway. *Street Railway Journal, 28th September, 1907.*

## Miscellaneous Electrical Subjects.

Direct and Indirect Methods of Electrical Purification of Water. By H. Leffmann. *Journal Franklin Institute, September, 1907.*

The Design of Plunger Magnets. By C. P. Nachod. *Electrical World, 21st September, 1907.*

On the Elementary Theory of Electric Oscillators. By J. A. Fleming (*continued*). *Electrician, 27th September,* and *4th October, 1907.*

Electric Percussion Drills. *Electrical Engineering, 3rd October, 1907.*

The Electrolytic Lightning Arrester. By R. P. Jackson. *Engineer, Chicago, 16th September, 1907.*

The Electrical Equipment of the S.S. *Mauretania. Electrician, 27th September, 1907.*

Magnetic Hysteresis Phenomena. *Electrical World, 28th September, 1907.*

Tension and Sag in Wire Spans. *Electrical World, 28th September, 1907.*

## Marine Engineering and Naval Architecture.

Combined Indicator Cards. By Chas. S. Linch (*concluded*). *International Marine Engineering, October, 1907.*

Cleaning Marine Boilers. By Lieut. H. C. Dinger. *International Marine Engineering, October, 1907.*

Single Screw Steam Light Vessels (*concluded*). *International Marine Engineering, October, 1907.*

The New North German Lloyd Steamship *Kronprinzessin Cecile. International Marine Engineering, October, 1907.*

The American Scout Cruiser *Salem. International Marine Engineering, October, 1907.*

The New Cunard Steamer *Lusitania. International Marine Engineering, October, 1907.*

The *Mauretania. Engineering, 20th September, 1907.*

Hydro-Plane Motor Boat. *Engineering, 4th October, 1907.*

## Streets and Pavements.

The Prevention of Dust, and Disintegration on Macadamised Roads in Chicago. *Engineering News, 19th September, 1907.*

## Water Supply.

The New Water and Sewerage Systems of Manila. *Engineering Record, 14th September, 1907.*

Water Purification at St. Louis. *Proceedings American Society Civil Engineers, September, 1907.*

## Sewage.

## Engineering Economics and Works Management.

## Miscellaneous.

Gold Mining and Gold Production, I., II., III. *Journal Society of Arts, 13th, 20th,* and *27th September, 1907.*

Electro-thermic Combustion of Atmospheric Nitrogen. *Electro-chemical and Metallurgical Industry, September, 1907.*

Corrosion of Iron. *Electro-chemical and Metallurgical Industry, September, 1907.*

Nickel Steel. By E. T. Lake. *Machinery, September, 1907.*

Daylight Illumination, X. *Illuminating Engineer, October, 1907.*

Modern Explosives. *Le Génie Civil, 14th, 21st,* and *28th September, 1907.*

The Foundry Department and the Department of Engineering Design. By W. A. Bole. *Proceedings American Society Mechanical Engineers, September, 1907.*

Heat of Evaporation of Water. By Arthur W. Smith. *Physical Review, September, 1907.*

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**The Editor of "The Engineering Review" invites Engineers and Manufacturers to forward advance particulars, drawings, blue prints, photographs, and any data that will enable him to publish a real and adequate description in these columns of any new work, machinery, or the installation of any plants, possessing special features of interest. Only such matter, however, as will enable us to present new and interesting information tending towards the advancement of the industry represented by the "Review" will be utilized. The cost of publication and engraving is borne by us, and no compensation is expected. In the endeavour to produce a really high-class and technically valuable machinery section the Editor seeks the co-operation of engineers and manufacturers.**

# The Second Engineering and Machinery Exhibition at Olympia.

THE second engineering and machinery exhibition held at Olympia was brought to a successful termination on Saturday, the 19th October. Although it could not be justly described as being thoroughly representative of engineering in its widest aspects, the impartial observer could not fail to be impressed by its great value as indicating the trend of development in many important respects.

Particularly was this the case in the machine tool branch, in which not only the machines themselves, but their equipment, were of a high order. More heavy tools were in evidence and several manufacturers of the highest standing were showing who were not represented last year. The method of cutting gear wheels by hobbers instead of from cutters appears to be finding increased favour, as there must have been nearly a dozen tools of this description—differing only in details—scattered throughout the show and nearly all working. Another point that impressed itself was the marvellous development in lathe power due to the introduction of high-speed steel and the supersession of the countershaft and belt shifting by the neater arrangement of the all-gear head, enabling full-belt speed and cutting power to be available on all diameters turned. The tool-holder, too, seems to be losing in favour in view of the increased tendency to adopt turret design. Another practice to be noted is that of including the driving motor as part and parcel of the machine, thereby rendering the whole self-contained.

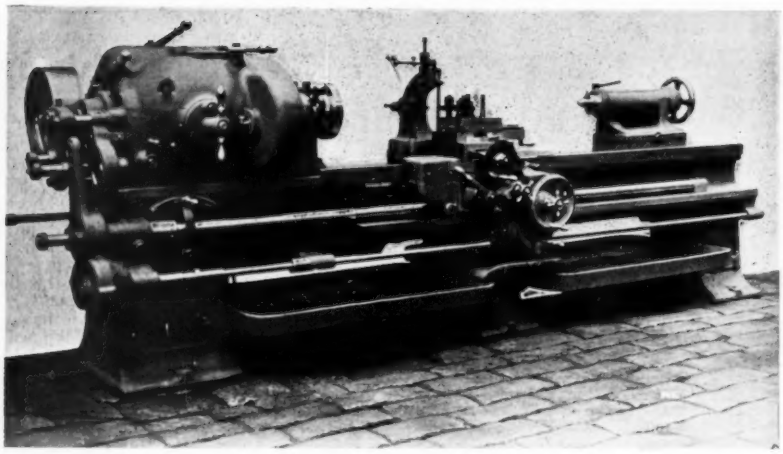
The relegation of cutting screw-threads to special machines is also suggested by the number of full automatic screw-threading machines shown, while the process of grinding as a finishing operation seems to find more favour than ever. Pumps formed a meritorious feature of the exhibition, the display ranking second only to that of machine tools. From the point of view of novelty the electrical side would be voted a disappointment, but the ubiquity of the electric motor formed an object lesson to those who have witnessed the successive displacement of the steam and gas engine in exhibitions of this kind.

The novelty seeker would find, too, satisfaction in more than one direction, for in addition to a diving tank, a wire-rope mono-rail, a new system of illumination, a novel lever lock, an apparatus for ringing the bell when a tool had reached its hardening point, &c., had he not yet another example of a rotary engine? Who shall say whether or not it has fallen to Herr Von Pittler to solve this perennial problem?

From a business point of view the direct results obtained by exhibiting, would, from extensive enquiries made, appear to be of considerable importance, although this must not be taken as applying to specialties for which there is but limited demand. Not that there were many in the show that could be legitimately included in the latter category, for the heavy side, represented by marine and locomotive engines and certain classes of machine and hydraulic tools, were not in evidence, and this, we apprehend, chiefly because of the trouble and expense involved in moving such heavy and bulky material, taken in conjunction with the comparatively short duration of the exhibition. Good business results imply a satisfactory attendance, and although misgivings were felt by some in the early period of the exhibition, they were speedily allayed when it was made known that the management had finally decided to include a vigorous advertising campaign in their programme. After all what was lacking in the way of numbers was amply compensated for in quality, as those who did attend were chiefly on business intent

Coming now to the amenities of the show, there was a highly successful series of lectures on the following subjects:—"Gas-Engines and Suction-Gas Plants," by Mr. Hal Williams; "From the Mine to the Finished Warship," by Mr. J. W. C. Haldane; "A New Method of Repairing Boilers," by Mr. H. Ruck Keene; "Sanitary and Ventilation," by Mr. A. E. Battle: "Submarine Telegraphy," by Mr. Charles Bright; "Japan and the Far East," by Mr. G. A. Goodwin; "Ferro-Concrete," by Professor Henry Adams: "Origin and Development of Steam Navigation," by Mr. J. W. C. Haldane: and one on "Tool Steel," by our metallurgical expert, Mr. Percy Longmuir.

Further, to terminate the exhibition there was what proved of more importance and interest to many, and none the less successful than the aforesaid lectures, an exhibitors' dinner held under the presidency of Mr. Arthur D. Ellis, M.I.Mech.E., supporting whom were Sir Alexander Binnie, Captain Sankey, Mr. Bennet S. Brough, Mr. Thomas Parker, jun., the secretaries of the Steel and Iron Institute, the Institution of Mechanical Engineers, and Standardisation Committee. The toast of "The Engineering Institutions" was proposed by

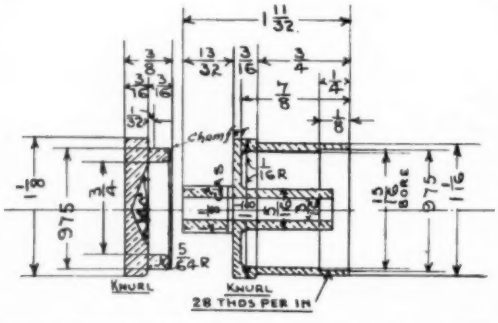


9-IN. "DARLING AND SELLAR'S" LATHE. A. HERBERT & CO.

Captain R. Sankey, and responded to by Sir Alexander Binnie; "The Exhibitors," by Mr. B. S. Brough, the secretary, Iron and Steel Institute, replied to by the Chairman; "The Press" by Mr. Leslie Robertson, secretary of the Standardization Committee, acknowledged by THE ENGINEERING REVIEW; "The Organizing Managers," by Mr. Marshall Wood, replied to by Messrs. Smith and Bridges, and "The Chair," given by Mr. A. L. Underwood.

Another pleasing function was the presentation, on the day preceding the close of the exhibition, of a handsome testimonial to Mr. C. H. Luke, of THE ENGINEERING REVIEW, subscribed for by a number of exhibitors and presented by Mr. W. H. Cook, of Fastnut, Ltd. The gift took the shape of a spirit tantalus, and was an acknowledgment of services rendered on behalf of the exhibitors.

Dealing with the exhibits themselves, an endeavour has been made in the following report to the extent that space will permit, to notice impartially those exhibits which, by reason of absolute novelty or improvements in design, are likely to prove of interest to those who were unable to visit the show. To make the record fairly comprehensive, it has been deemed advisable to briefly refer to appliances which may by some be regarded as more or less old friends. The report in any case does not pretend to be complete, and omissions must not be taken to imply anything more than that they have been previously dealt with in these columns, or that they are already well known.




SYPHON LUBRICATOR BODY AND CAP MADE FROM BRASS BAR AT ONE OPERATION ON A NO. 2 FULL-AUTOMATIC SCREW MACHINE. A. HERBERT, LTD

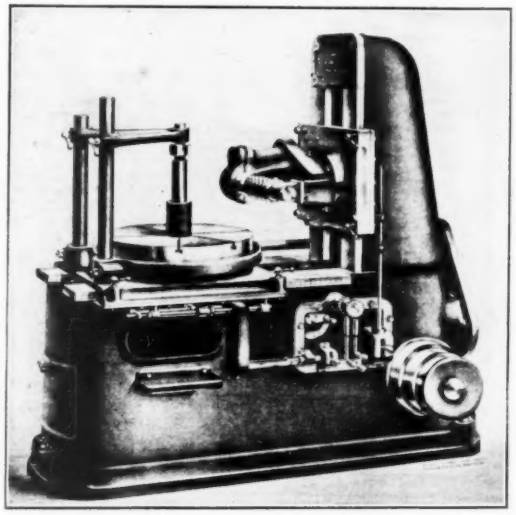
## MACHINE TOOLS.

*Alfred Herbert, Ltd.*, Coventry. This firm exhibited a very complete range of labour-saving tools in actual operation. The stand itself was a light structure, composed of steel girders, the line shaft being placed centrally, and driven by a Lancashire Dynamo & Motor Co.'s 30 h.-p. motor, carried on top of the stand. The machines were arranged in two rows, down each side of the stand, and were driven from above by a countershaft. A No. 17 combination turret lathe, with patent chasing saddle, was shown. This machine, which is for dealing with heavy chucking work, was in operation machining bevel gear blanks

from mild steel stampings. It is suitable for the most involved and difficult work up to 20 in. diameter, and is provided with an exceptionally large spindle, which will allow 5¼ in. diameter bars to pass through it. The outfit of tools used in machining the bevel gear flanks is interesting, as it consists of standard holders, which, with the addition of small and inexpensive cutters, may be adapted for any ordinary work. The No. 6 capstan lathe shown is a similar machine to the No. 17 lathe, but of smaller capacity. It was shown in operation machining spur gear blanks from mild steel stampings. The tools on this machine are also of a widely adaptable character. The smallest size of lathe for chuck work, a No. 4 capstan, was shown in operation machining a small commutator bush in cast-iron. The special advantages of the chasing saddle were shown by chasing an external thread on the end of the bush. The machine is fitted with the firm's patent single pulley headstock, which is driven by constant speed pulley, the different spindle speeds being all obtained by levers at the front of the headstock, and the machine being instantly stopped, started, and reversed by friction clutches. Other machines noticed were the following: A No. 2 patent hexagon turret lathe, shown in operation producing bolts from mild steel bar, using the firm's new roller steady turning tool, of great interest, in that the application of the rollers has enabled the speed to be increased considerably. This machine is also fitted with the single pulley headstock, giving sixteen spindle speeds in either direction. This type of lathe is used solely for producing bolts, pins, studs, &c., from the bar. The "Coventry" patent self-opening diehead is used for screwing the bolts, and this is an interesting tool for the rapid production of accurate screw threads.

The No. 2 full-automatic screw machine shewn is the medium size of the firm's well-known series of automatic screw machines, and admits bars up to 1¼ in. diameter. It was shown in operation making a syphon lubricator body and cap, from brass bar, at one operation. The outfit of tools and the operations performed were exceptionally interesting, as the body is countercored, formed, tapped, and knurled: the shank is screwed, and the name is rolled on the outside: the cap is recessed, knurled, and screwed. Both these pieces are finished complete at one operation on a single spindle machine. The article is shown by the accompanying line illustration.

No. 8 vertical milling and profiling machine.—This is a heavy machine with exceptional capacity and ease of control. It was shown in operation face-milling with a high-speed inserted-tooth milling cutter. The firm's patent dial feed motion is fitted, by which any desired feed is obtained by simply rotating a hand-wheel.



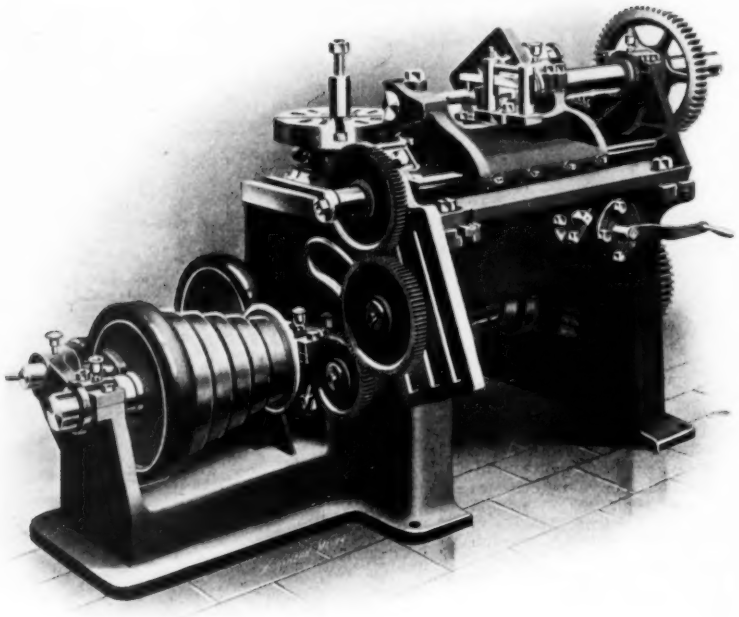
GEAR HOBBING MACHINE. ALFRED HERBERT, LTD.

No. 1 vertical milling machine.—This is a similar machine to the No. 8, but of a smaller size. It was shown in operation facing up cast-iron blanks.

No. 12 horizontal milling machine, with patent dial feed motion.—This machine was shown in operation taking a heavy roughing cut with a spiral cutter. The principal features of this machine are great strength and rigidity, combined with ease of control on the part of the operator.

A valve grinding machine was shown in operation grinding the valve seats of small motors. This machine is capable of doing three times the work of that performed by hand.

Other machines exhibited were a 9 in. centre high-speed heavy reduction lathe; a "Newall" universal grinding machine, and a 6 in. cold saw. Gear cutting was prominently illustrated on the stand by a new spur and spiral gear hobbing machine and a new machine for generating worm wheels, both of which we illustrate. In the gear hobbing machines the bed is of box pattern, cast in one piece, and well ribbed internally; provision is made for catching all oil and cuttings. The slides are of ample width, and have square edges. The work table has a large annular bearing, and a tail bearing fitted with lock-nuts to prevent any lifting tendency. The main worm wheel which rotates the table



WORM WHEEL GENERATING MACHINE. A. HERBERT, LTD.

is accurately cut to Brown & Sharpe standard; the driving worm is of steel, hardened and ground, and provided with ball thrust bearings. The work arbors have taper ends which fit in the table, and are firmly secured by a draw-bolt which passes through the table, and is easily accessible through an opening in the side of the bed. An efficient stay is provided for steadying the outer end of the work arbor when cutting a gang of gears; this stay can be readily removed when not required. The table saddle has a long bearing on the bed, with a narrow guide fitted with taper gibs. It may be firmly locked in position by conveniently placed handles. The adjustment of the hob saddle is by means of taper gib. Power elevating motion is provided for rapidly returning the hob after finishing a gear; this is thrown into action by means of a lever operating a friction clutch. A scale let into the side of the vertical head enables the operator to return the saddle to the correct position without measurement. The drive to the hob is through hobbed hollow face spiral gears, no bevels being employed; the reduction in ratio is effected by the last pair on the hob spindle which ensures a powerful and steady drive. The feed motion is a new feature, and greatly simplifies the operation of the machine, as the correct feed is obtained instantly by means of a lever. The feeds are driven by the work table itself, and are constant irrespective of the size and speed of the blank being cut. The ratios of feed provided are $\frac{1}{60}$ in., $\frac{2}{60}$ in., and $\frac{3}{60}$ in. per revolution of the work. No loose change wheels are employed.

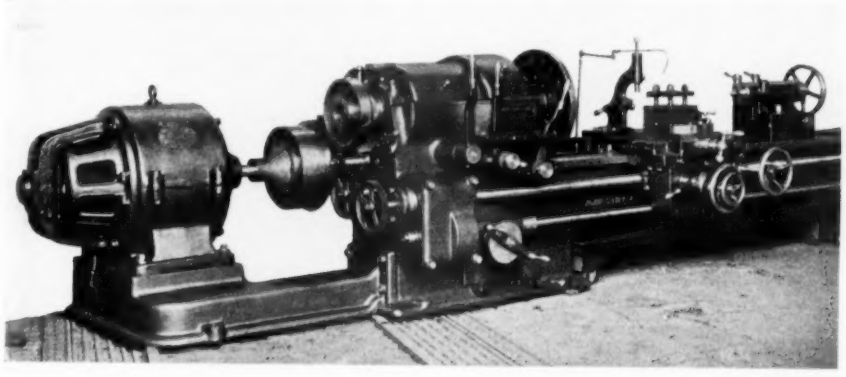
The worm wheel generating machine automatically generates worm wheels of any lead, using either a hob or a fly cutter, which, when cutting, represents the worm which is to gear with the finished wheel. The axis of the cutter arbor is set in the same position relating to the wheel that is being cut, as the axis of the worm will have. The cutter is fed into the blank by being moved along its own axis as it revolves. The machine depends for its action only on the correct selection of the change gears, of which there are two sets: one for rotating the cutter arbor and the other for feeding it in correct relation to the rotary movement of the blank. The headstock drives through a high carbon steel shaft, running in phosphor bronze bearings; the driving worm is also of high carbon steel, and a ball thrust collar is

provided. The nose of the work spindle is bored taper to accurately locate the work which is secured by a nut at the bottom. The saddle carrying the cutter slide is moved to or from the centre of the work spindle by a screw and nut, which can be adjusted to remove any backlash due to wear. The distance between the centres is indicated by a steel scale let into the bed. The cutter slide has a bearing on the saddle of great length in proportion to its width; the feed screw being placed centrally there is no twisting tendency. The thrust of the cut is taken by solid metal; the nut on feed screw is adjustable for wear. The maximum working centres are 20 in., minimum, 3 in., and the maximum circular pitch cut is 2½ in.

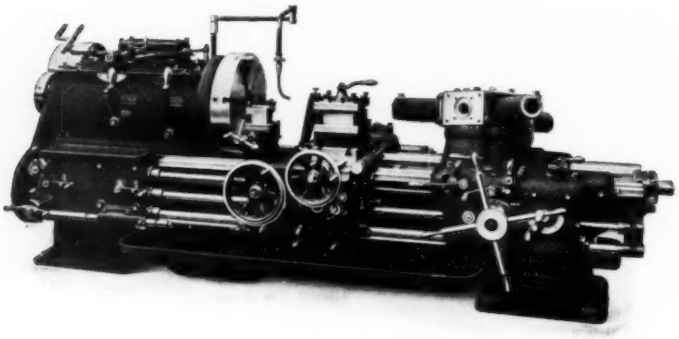
*John Stirk & Sons, Ltd.*, Halifax. The most conspicuous item of this exhibit was a 3-ft. 6-in. high-speed radial drilling machine, direct driven by 16 h.p. motor. The spindle is balanced for tapping, and a new pattern combination clutch enables the spindle to be stopped, started, or reversed with great facility. There are eighteen spindle speeds, ranging from 16 to 530 r.p.m given by the nine change driving box and the double gear on the saddle. Quick change feeds are provided, which range from 105 to 32 cuts per in. The weight of the machine is 4½ tons, and it will easily drive a drill 1 in. diameter through cast iron at the rate of 11 in. per minute. The machine shown is the firm's standard belt driven type, with constant speed drive, and the motor was attached to the gear box, showing with what readiness one of the belt driven machines could be converted to electric drive.

This firm had also a 30-in boring and turning mill driven by a 2½ h.p. motor, which was built into the main frame, and runs at speeds from 800 to 1,600 r.p.m. The table speeds range from 5 to 250 r.p.m. The machine has double gear, enabling 40 ft. per minute to be obtained on all diameters from 3½ to 28 in. A capstan type tool holder is fitted accommodating four tools. The feed is by gear box, which gives a range of nine feeds operative in each direction. On the same stand was an 8-in. high speed lathe and a sliding, surfacing and screw-cutting lathe, while on the stand of Messrs. Sanderson Bros. & Newbould, whose "Saben" steel tools were used on the Stirk machines, was a fine 12-in. high speed lathe. This machine is of the firm's standard belt-driven type, with 35 h.p. electric motor attached. It is, therefore, available for either belt or motor drive immediately. There are sixteen spindle speeds from 10 to 200 r.p.m. These are all controlled by two handles, and it is quite impossible to put two gears in at once. The quick change feeds give ⅛ in., $\frac{1}{16}$ in. and $\frac{1}{32}$ in. traverse in either direction. The spindle has a 4-in. hole through. The headstock is cast in one with the bed, and the driving is from a pulley running at constant speed. The lathe weighs, complete with motor, seven tons, and was shown taking cuts on steel of ½ in. by ⅛ in. at 75 ft. per minute in mild steel.

*H. W. Ward & Co.*, Birmingham, displayed a fine 12 in. centre all-gear combination turret lathe which we illustrate, a 9 in. chucking lathe, various capstan lathes, two plain milling machines, a new thread-milling machine, one bush and one cutter grinder. The 12 in. turret lathe is a well designed and heavily built tool, suitable for all classes of chucking and bar work. The headstock is arranged with fast and loose pulleys on the back shaft, or with single pulley and friction clutch driven directly from the main shafting. Sixteen changes of speed in geometric progression are obtained by means of three levers, which are so arranged that it is impossible to have more than one train of gears in mesh at the same time. The eight fast speeds are transmitted to the spindle by means of a friction clutch of large diameter, thus allowing the drive to be taken up gradually and without shock. The eight low speeds are



12 IN. HIGH-SPEED LATHE. JOHN STIRK & SONS.



12 IN. INCLINED TURRET LATHE. H. W. WARD & CO.

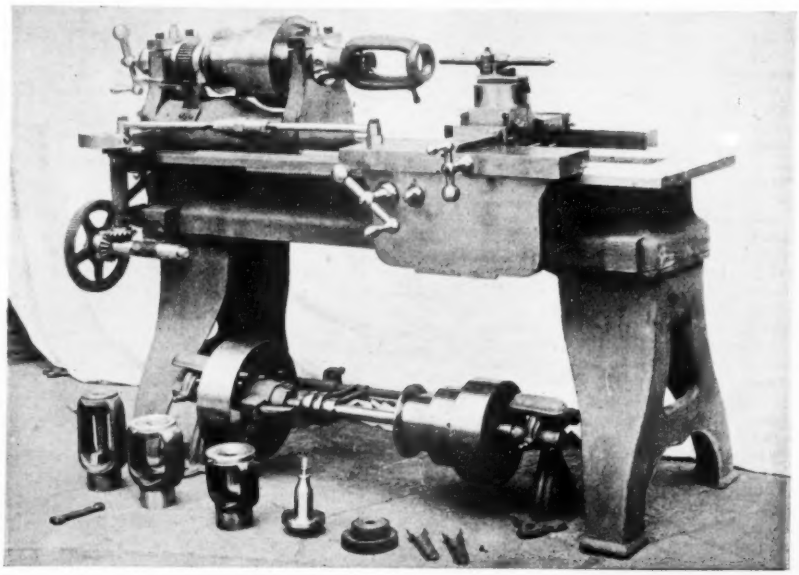
obtained by a pinion and gear ring on the chuck. This pinion is withdrawn when the chuck gear is not in use. Only those gear wheels which are actually in use are in mesh, *i.e.*, there are no idlers. The chuck ring is 20 in. diameter on the pitch circle. The saddle has automatic sliding, surfacing and screw-cutting motions, driven by gearing from the end of the spindle through a change gear box under the headstock. These gears give eight changes of feed to the sliding and surfacing, and four to the screw-cutting motions. These feeds are reversible by lever on the change feed gear box. Four adjustable automatic stops are provided for each motion, and these stops are so set to suit the work in hand that by their means four different diameters and four different lengths may be turned. The chasing motion is applied to the saddle, and is obtained by means of a detachable hub and nut, the hub being driven by gearing from the end of the spindle through the quick change gear box under the headstock. This gear box gives four changes and a reversing motion to the screw, so that with each hub four different threads may be cut either right or left-hand by means of the two levers. The changes in the box are in the ratio of 1, 2, 3, and 4 to 1, so that, supposing a 4-thread hub is to be in use, it would allow 4, 8, 12, and 16 threads per inch to be cut. The turret rest consists of a strongly designed saddle sliding directly on the bed, and operated either automatically or by hand. The turret is hexagonal in form, is inclined to allowed tools to clear the star handle on the apron, and revolves on a pivot of large diameter. It is indexed by a cylindrical steel bolt. When it is required to revolve the turret, the bolt is withdrawn by a lever placed in a convenient position, and returned to its place afterwards by a strong spring acting directly under it. After indexing it is firmly locked in position by a conveniently placed lever. The feed to the turret rest is obtained through the gear box on the front of the bed. Four reversible feeds are obtained here, which together with three changes given by sliding gears in the apron, makes a total of twelve feeds. A quick power traverse in either direction is also fitted, driven by belt from initial shaft.

*Charles Churchill & Co., Ltd.*, Finsbury.—As reference was made at some length to the exhibits of this firm in the article on the exhibition that appeared in the last issue, it will be unnecessary to repeat our remarks. It may be added, however, that much interest was shown in the "Simplex" 4-spindle automatic lathe, the vital difference between which, and the ordinary automatics, is that, while they are furnished with a revolving turret carrying several tools which are brought into operation one after another, the turret of the "Simplex" machine carries four bars of stock which are all operated upon simultaneously by a single set of tools. In this way each tool is employed almost continuously. By dividing the cutting duty as equally as possible between the various tools, the highest advantage of this method is secured. Each spindle in turn arrives where the feeding and chucking mechanism, which is located in the bed, can do its necessary part by means of phosphor-bronze shoes which actuate the feed tubes and chucking spools. The tool slide is driven in a novel and ingenious manner. Instead of employing a variety of cams in the usual way, motion is taken from the turned and polished edges of a disc mounted on the cam shaft in such a way that it can be swung on its axis by means of an ordinary spanner so as to give any throw within the capacity of the machine. A unique and important feature of the "Simplex" automatic is the patent die and tap spindle. Its operation is entirely different from the ordinary method, and requires no reversal of the spindle for backing off the die. The work normally revolves left-handed, and the die is so mounted that, by means of a special clutch, it can be run in the same direction as the work, but at a faster or slower speed as may be desired. This allows the die to form

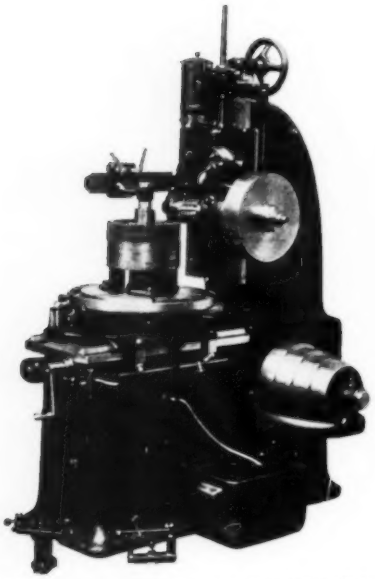
the thread at a suitable cutting speed by being driven that much faster than the spindle, and then to wind itself off again in consequence of being retarded. Other special points are the improved method of rotating the cylinder, the two cross slides set at an angle, and the two special top forming slides, all of which deserve special notice.

Among minor matters of interest on this stand may be mentioned a little machine for quickly forming the heads on rivets up to ¾ in. diameter by a noiselsss spinning action. The specially shaped twin rolls in the holder at the lower end of the revolving spindle, when brought in contact with the rivet shank, produce a condition which causes each half of the rolls to revolve independently on its axis, thereby rolling or swaging the rivet shank into the form desired. This method of riveting thus eliminates any hammer-like blows and their accompanying noise. A "Biernatzki" automatic gear generator—a machine already described in THE ENGINEERING REVIEW—was shown in operation, and attracted much attention.

*Selig, Sonnenthal & Co.*, London, E.C.—A profusion of tools, including lathes, radial drilling machines, shaping machines, disc grinders, comprised this exhibit, those of latest design involving new features being an oil grooving lathe, a gear hobbing machine, and a neat high-speed radial drill. The oil grooving lathe shown in the illustration below is equipped for forming oil grooves within bushings, axle-bearings, and the like, but may be fitted with a work-holder for enabling grooves to be formed upon shafts, journals or studs. When arranged as shown, the bushing to be grooved is held in a special chuck revolved by the headstock. On the carriage is a tool post which takes a boring tool holder of the size required for the bushing to be grooved. A crank mechanism causes the carriage to move to and fro along the bed, sending the boring tool in and out of the bushing at a predetermined ratio of reciprocations of carriage to revolûtions of the spindle. The drive of the carriage is accomplished through a series of gears from the spindle to a vertical shaft, at the top of which is a crank disc. The crank pin is adjustable in its disc to an index in order to determine the length of travel of the carriage. The ratio of reciprocations of the carriage and consequently pitch of spiral to revolutions of spindle is determined by change gears in the train of gears from the spindle. Fine adjustments of the tool to the work are accomplished by a turnbuckle in the connecting rod. Hand adjustments to the carriage and top rest are provided, the rack pinion being arranged to be disengaged when the machine is in operation. An ordinary axle box requires only one minute to groove and the machine is capable of grooving bushing, up to 20 in. length and 6 in. internal diameters



OIL GROOVING LATHE. SELIG, SONNENTHAL & CO.



GEAR HOBBING MACHINE. SELIG, SONNENTHAL & CO.

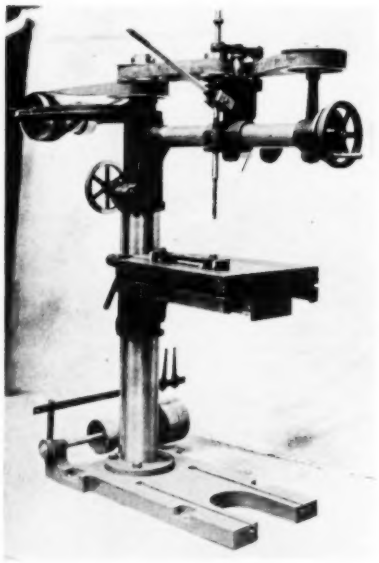
The feature of the automatic gear hobbing machine, also illustrated, is that there is a smaller overhang of the hobbing spindle from the face of the upright than is usually found, ensuring great rigidity in the driving mechanism. Again, a very smooth and powerful drive is obtained by a large driving gear with internal teeth. An outer support to the work mandrel, to prevent the latter bending under the pressure of the cut, is also provided. This is adjustable vertically and horizontally for different lengths of mandrels and sizes of work. Adjustment is provided for wear of the dividing worm and wheel preventing backlash and blocking motion is also provided for the feeds.

The sensitive radial drilling machine referred to has been designed for drilling large, small and awkward work usually done on more expensive machines, and for drilling and recessing holes spread over large surfaces, such as switch-boards, motor radiator plates and gear boxes.

The table rises and falls by hand wheel and screw so that any shaped piece may be brought within range of the spindle. Further, it can be swung entirely out of the way so that the foundation plate and pit may be used for large work. The table is provided with deep sides with T slots, so that work may be bolted against it, the top of the table also having two T slots and a hole in the centre for steadying a boring bar when boring or counter-boring. A drawer for tools is fitted under the table. The foundation plate is designed so that a pit may be sunk to take long work and is provided with two T slots on the face. The spindle pulley has a double sleeve to take up belt pull, so that the spindle has three bearings. The machine is entirely belt driven, no gears being required, the belts being extra wide. A dividing plate at the end of the arm for drilling holes at varying centres, without marking off is also supplied.

*Pollock & MacNab, Ltd.*, Manchester, exhibited a series of their well known "Apollo" lathes, a radial drilling machine, a crank shaper, all of which were motor driven, using tools supplied by Messrs. Firth & Sons, Ltd., Sheffield.

In particular may be noted the combination turret lathe for boring and chucking work up to 23 in. diameter, and for turning from the bar up to 4 in. diameter. The headstock is of the single-pulley all-gear type, having sixteen direct spindle speeds without the necessity of using a countershaft, the required speed being obtained merely by moving the levers in front of the gear casing. The feed box is self-contained, and may be removed and inspected without disturbing the remaining parts of the lathe. The whole of the wheels are in steel, and give eight rates of feed for every spindle speed in forward and reverse direction; also four different threads for screw-cutting without altering the change wheels. These changes are made by



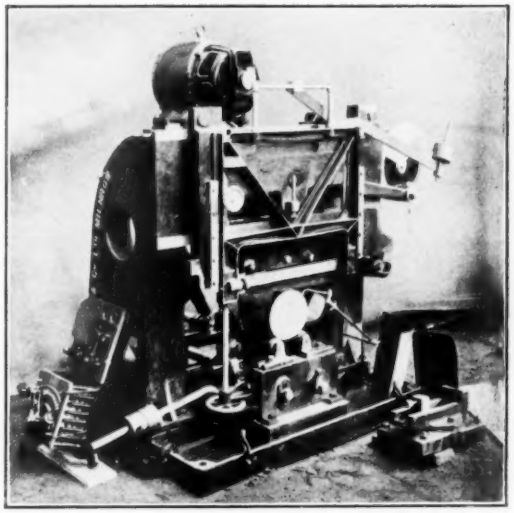
SENSITIVE RADIAL DRILLING MACHINE. SELIG SONNENTHAL & CO.

simply turning the pilot-wheel, the latter controlling a double spring key sleeve for engaging any of the pairs of wheels for the indicated feeds. These four are doubled by moving a lever, making eight feeds in all. The rates of feed for the front carriage, both cross traverse and sliding traverse, are $\frac{1}{15}$ in., $\frac{1}{16}$ in., $\frac{1}{20}$ in., $\frac{1}{24}$ in., $\frac{1}{32}$ in., $\frac{1}{40}$ in., $\frac{1}{60}$ in., $\frac{1}{80}$ in., and for turret slide traversing are $\frac{1}{16}$ in., $\frac{1}{32}$ in., $\frac{1}{40}$ in., $\frac{1}{48}$ in., $\frac{1}{64}$ in., $\frac{1}{80}$ in., $1\frac{1}{2}$ in., and $\frac{1}{160}$ in. The main turret is hexagonal and is set at an angle of 15 degs. It is rotated by hand and not automatically. The automatic feeds are eight in number to the turret carriage, and are actuated through an apron of the double-frame type so that the feed wheels and shafts are supported in two bearings and not overhung. A special feature is, that the worm drive for this apron has a ball thrust

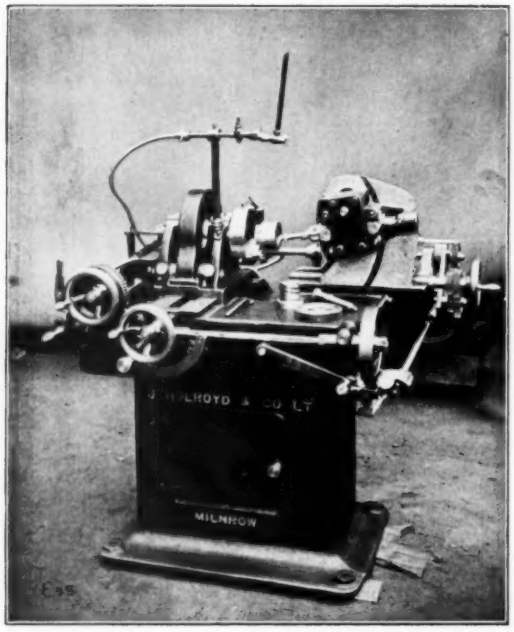
There are six dead stops, with knock-off motion, for each of the turret faces, controlled by an hexagonal bar along the front of the bed, and this bar is connected to the turret so that, when the latter is rotated, the correct stop comes into a vertical position to travel against the disengage for dropping the worm. The front carriage is fitted with a four-tool revolving rest. The trip motion for the cross traverse for each of the four tools is actuated from a bar across the carriage, which, when moved, disengages the driving worm in apron. This bar has four slots, and each slot is fitted with a tappet, each tappet being adjustable to any point throughout the length of the cross traverse motion, and not, as some are, merely through the range of a short set screw, say five or six inches. The longitudinal trip motion is controlled from a bar at the front of the bed which has four slots with adjustable tappets (one for each tool) for disengaging the falling worm actuating the mechanism in the apron. The carriage has automatic cross traverse and longitudinal traverse. The screw-cutting and traverse motions are interlocked to prevent any possibility of engaging at the same time. There is a revolving dial indicator, so that when cutting odd threads the nut can be always engaged with screw at the right point. The whole of the feed motions are actuated through an apron of the double-frame type. The cutting power is constant at 7 b.h.p. and is equivalent to a cut on ordinary metal of $\frac{1}{8}$ in. × $\frac{1}{32}$ in. at 60 ft. per minute. The front carriage is arranged so that an attachment for taper turning, boring and chasing can be fitted.

*John Holroyd & Co., Ltd.*, Rochdale. This exhibit comprised a number of screw-milling machines, gear and worm wheel hobbers, light milling machine and turret lathe, and a new type of hack sawing machine. The latter, which we illustrate, cuts off circular blanks and tubes from 10 in. to 5 in. diameter, and can also be arranged to saw off beams 10 in. by 6 in. It cuts off true blanks and wastes a very small quantity of material. The machine consists of a strong base on which are mounted two uprights that carry the cross rail on which a slide is mounted, which in turn carries the saw frame in a vertical slide. The horizontal slide is moved on the cross rail by a long connecting rod and crank, and 4—1 gearing driven by a 14 in. pulley for a $3\frac{1}{2}$ in. belt. It runs on rollers and so works freely. The saw frame is balanced by an adjustable weight on a long lever, so that the pressure on the saw can be regulated. The saw, which is 26 in. long, is held in special grips on the ends of the saw frame. The bar to be cut rests on two roller brackets, and is revolved by a pawl fastened in a reciprocating frame, which is kept up to the bar by a balancing weight, and is moved by a roller fastened to the horizontal slide running in an inclined slot which is part of the rocking frame. The bar to be cut is held down by a steel bar held in adjustable brackets. The rollers on the back support are set at an angle, and so the bar to be cut is forced on to a back stop. The front roller brackets are adjustable by screw and handle, so that they can be quickly adjusted for bars of different diameters.

The screw milling machine is of entirely new design, and is adapted for cutting both internal



10 IN. HACK SAWING MACHINE. JOHN HOLROYD & CO.




SCREW MILLING MACHINE. J. HOLROYD & CO.

and external threads. On it caps and bushes can be screw milled either with a single thread cutter or with an annular cutter, the latter cutting all the threads at one revolution. The machine consists of a bed of strong box section, mounted on a suitable box standard, and carries slides to which the cutter and work headstocks are fitted. The cutter headstock carries a steel spindle running in parallel gun-metal bearings, the end thrust is taken by a hardened steel tail pin. The spindle nose is bored out No. 3 Morse taper to receive the cutter mandrel, which is also screwed on the end to fit corresponding hole in the spindle. The cutter head is arranged to swivel over to suit the angle on the thread being cut, a rule graduated in degrees and minutes being provided for this purpose. Provision is made for locking the head to the slide, and no matter what angle the head is swung to, the cutter is always in the correct position on the work to commence milling. The drive to the cutter head spindle is from a pulley 4½ in. diameter for 2 in. belt, through spur gearing with a ratio of 4 to 1. A three jaw universal chuck is fitted to the spindle nose for holding the work. The feed to work head and cutter head is connected by a clutch which is operated by the handle placed in front of the machine. The drive to the feed is by a 6 in. by 1¼ in. pulley through bevel and spur gears, to a drop-out worm and wheel, then through another pair of bevels on to change wheels connected to the cutter head stock screws. An automatic knock-off is provided to the worm box, which is timed to operate at a small amount over a complete revolution; so there is no mark on the thread when they meet.

*John Lang & Sons*, Johnstone.—The feature of this stand was a fine 30 in. swing surfacing and boring lathe, a view of which is shown. Two important developments are to be noted in connection with this tool, namely, the variable-speed drive and the automatic speed changing mechanism. With these in operation, when surfacing work such as cylinder covers, face-plates, &c., the revolutions of the spindle automatically increase as the diameter being turned becomes smaller. The fast headstocks can be used with single and treble gear, and are so arranged that, even when running at the greatest speed, there is a reduction by gearing. With this arrangement the tool has greater power when turning smaller diameters than when the belt is used driving direct to the main spindle. The automatic speed-changing mechanism, by which the revolutions of the spindle increase automatically as the tool travels towards the centre, insures that any surface can be finished in less than the time taken on a lathe having the ordinary step-cone drive, where a workman will not change the position of the belt while surfacing. The beds are of the covered type, allowing the saddle to have its longitudinal guide seven times greater than its width. The covers, which may be seen in illustration extending the whole length of bed, are so placed as to prevent cuttings from falling on the working surfaces. These covers are fixed to the bed, and are independent of the movements of the saddle.

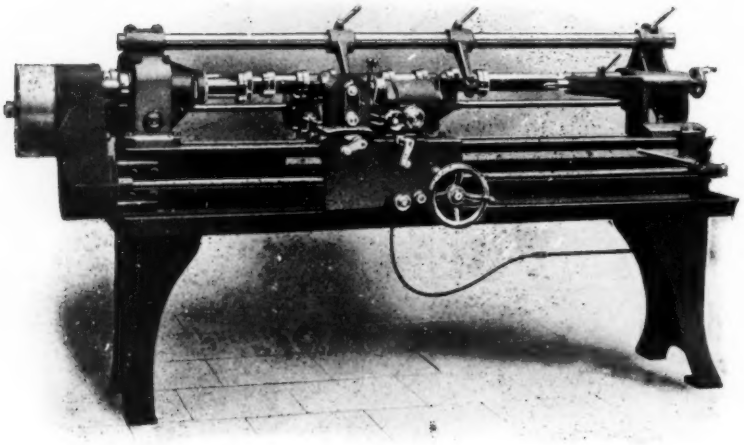
Another tool shown was a hollow-spindle capstan lathe for bar and stud work. This tool has also a variable speed drive on the fast headstock. A hand-wheel is conveniently placed, so that the workman may get the correct cutting speed without handling the belt. The same operation which changes the speed moves an index to show at all times the diameter being turned. Two pairs of fast and loose pulleys are used, thus allowing the operator to change immediately from a correct turning speed to one for screwing with the die head. The chuck is arranged with self-centring grips, which allow the bar to be loosened, moved forward, and again gripped without stopping the lathe. Special attention may be drawn to the short overhang of the self-gripping chuck from

the front bearing, and to the design of mechanism, by which the workman can tighten the bars without using abnormal force. The loose headstock embodies a new departure. The main spindle carries a centring tool besides an ordinary centre. Either of these may be immediately brought into alignment with the fast headstock spindle. When work necessitating a long projection from the chuck is being operated on, this centring tool is brought into position and the bar centred. The ordinary centre is then immediately brought into position and steadies the point of bar. Thus the work is gripped firmly at one end, and runs in a centre at the other.

A universal sharpening machine for twist drills, milling cutters, rose bits and small tools generally calls for mention, as does also the firm's standard 8¼ in. centre sliding, surfacing and screw cutting lathe.

*C. W. Burton, Griffiths & Co.*, London, E.C., exhibited on a large stand a number of machine tools, mostly in operation. Most of them are well known, but we may single out for detailed description a cam shaft milling and grinding machine. This, although primarily designed for petrol motor work, can also be applied for producing irregular formed work of any description within its capacity. One of the most important special features of the machine is, that there is no indexing

SURFACING AND BORING LATHE. JOHN LANG & SONS.



CAM DRILLING AND GRINDING MACHINE. BURTON, GRIFFITHS & CO., LTD.

mechanism required. A former shaft, having a keyway cut its entire length, runs along the back of the machine, revolving by worm gearing in unison with the work. On this former shaft are placed as many cast iron formers as there are cams to be cut. When the formers are set up, any number of shafts can be produced, which will be exact replicas of each other. The machine is, therefore most suitable for operation by comparatively unskilled labour, as no error on the part of the workman can affect either the shape, the timing, or the longitudinal position of the cam. The machine will also generate its own cast iron formers. Although this probably does not require to be done very frequently, it is a great advantage in this machine that it can be done easily and inexpensively. All that is required is, in the first place, a master former which is an exact duplicate of the cam to be produced. This master former is mounted on a suitable arbor carried in the former shaft driving spindle, the former shaft having been previously removed. A master former arbor with four keyways is provided for four cylinder shafts, or six keyways for six cylinder cam shafts. These keyways are correctly spaced for the angular relation of the cams, so that it is a simple matter to finish the former blanks to correct shape after they have been bored and keywayed, the operation being exactly the same as when milling a cam shaft, excepting the location of each former in relation to its keyway. The saddle carries two milling heads, each positively driven by bevel gearing from a driving shaft at the back of the machine. One of these heads carries a high-speed end milling cutter for rapidly roughing out the work and bringing it to approximately its correct contour. The other head carries a face milling cutter, which takes a light finishing cut over the cam and brings it to a perfectly accurate form. The power saddle traverse is driven from the headstock by spur gearing, and there is also a quick hand traverse. A shaft running along the top of the machine serves to carry any desired number of steadies.

*Messrs. Butler & Co.*, Halifax, displayed several fine tools, all of which were shown running to illustrate the quality of the "Mushet" high-speed tool steel made by *Messrs. Samuel Osborn & Co., Ltd.*, Sheffield, who jointly occupied this stand. A new design high-speed vertical drilling and boring machine, which we illustrate, perhaps attracted most attention. It is an unusually powerful machine, and is capable of testing to its utmost endurance any twist drill up to 3 in. diameter. At a trial with this machine a $\frac{3}{4}$ in. hole was drilled through 3 in. thick of cast iron at the rate of nearly 30 in. deep per minute, and a $2\frac{1}{2}$ in. hole was drilled at the rate of $2\frac{1}{2}$ in. per minute from the solid in mild steel, the twist drills in both cases being of the high-speed steel of the manufacture above mentioned. The main features of the machine comprise a fixed and solid worktable with adjustments in each direction by quick pitch screws and in which the weight is taken solidly on the baseplate. A massive drill headstock is fitted to a strong vertical column and balanced for quick and easy adjustment to the height of the work. The spindle is supported in a large steel sleeve with gun-metal liners and accurate ball thrusts at top and bottom. This sleeve has a rack cut in its face for the self-acting feed. It has also a slow

hand traverse and a quick hand adjustment, each engaged or disengaged instantly, and it has a neat and sure automatic trip motion. The positive feed is driven by spur gears from the spindle and variable either by a three-speed feed box or a quadrant plate with change wheels as desired. The driving shaft has capped bearings with gun-metal bushes, and is driven by the speed cone direct or through the double gear, as the case may be. The machine is self-contained, the countershaft being fixed on the base of the machine with starting lever close at hand. The illustration shows the machine driven by electric motor. In the case of belt-driving from the line shaft the spur wheel shown is replaced by fast and loose pulleys. The machine will admit work up to 36 in. diameter, the capacity from spindle end to the top of the table being 2 ft. 4 in. The self-acting travel of the spindle in the drill head is 16 in.

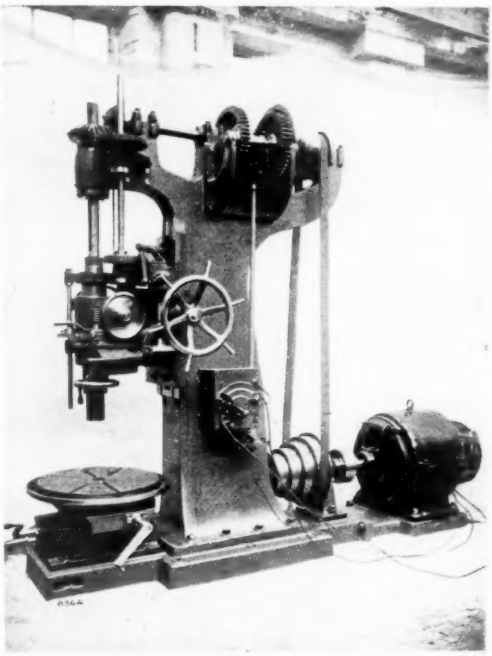
A 48-in. double standard vertical boring and turning machine also figured conspicuously on this stand. In this machine each tool bar has independent feed motions in each direction operated by a separate gear box on each side of the machine, giving three changes of feed by the handle shown, and an additional three changes by a change wheel on the end of the cross-slide, reversing motion being also provided. The tool bars may be swivelled to any angle and retain their self-acting feeds in any position. An important feature is the self-contained countershaft, which enables the machines to be placed often in positions otherwise unsuitable if the erection of scaffolding for a countershaft has to be considered. Another advantage of this arrangement is the facility afforded for the application of an electric motor for driving. This is very easily accomplished by securing cross girders on which the motor can be secured and driven to the countershaft either by gearing or belt. Still another feature is a belt shifting device, enabling the belt to be moved with the greatest ease from one speed to the next while the machine is running without danger to the workman.

Shown in operation was also a high-speed planing machine to plane up to 4 ft. in length by 3 ft. square, and specially designed for use with high-speed tool steel. In addition to the unusual depth and weight of the bed, one of the noteworthy features is that the whole of the gearing is neatly arranged on specially prepared flanges inside the bed, the shafts being carried in strong frames. The advantage of being able to remove the whole of the gearing without disturbing the main bed will be apparent, but a still more important advantage is that the driving shafts are so closely supported that torsion and vibration are reduced to a minimum. A very large idle wheel gears into the rack on the table and engaging several teeth gives a smooth and powerful drive.

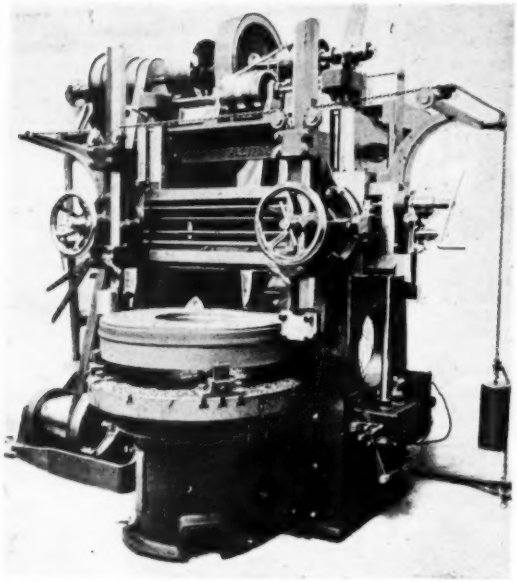
The enormous power of the gearing enables the use of comparatively light belts running at a high velocity which are much more economical than wider and slower running belts, and put much less strain on the machine in moving from one pulley to another. The tool box is of improved design, being bolted in a circular slot in the vertical slide, so that it may turn completely round and permit of using the tool in a horizontal position. The vertical slide is of specially strong form with a long bearing on the back slide, the latter having also a graduated swivel slide for planing angles. The novel arrangement of the driving mechanism, ensures a powerful and smooth cut, and the easy and quick manipulation of the machine, changing of stroke, &c.

We also select for illustration a power-driven portable drilling and tapping apparatus for bolting or clipping to a large casting which it is inconvenient to carry to a stationary drilling machine.

It will be noticed that the foot being secured,



HIGH-SPEED VERTICAL DRILLING MACHINE, J. BUTLER & CO.



VERTICAL BORING AND TURNING MACHINE. J. BUTLER & CO.

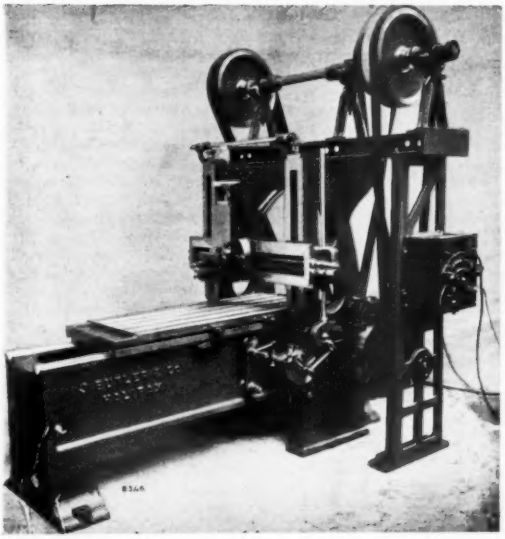
the position of the drill head may be adjusted horizontally and vertically on the screws. Attention may be directed to the connecting block between the two screws which is designed to enable the drill spindle to be tilted in either plane to a correct vertical position, thus avoiding the necessity of packing the foot to suit a rough casting.

The spindle is driven by machine cut spur wheel and pinion, the rope pulley driving by a steel mitre wheel between a pair of inverted mitres, the arrangement being such that by the movement of a small lever, the direction of the spindle may be reversed for tapping. Moreover, the spindle is provided with a very neat arrangement, leaving it free of the feed screw for quick withdrawal. The feed is given by hand by the sprocket wheel shown. The head is light enough for a man to lift and strong enough and powerful enough to drill a 2 in. or tap a $\frac{3}{4}$ in. diameter hole.

A 10 in. stroke slotting machine, embodying some interesting features, completed this exhibit. The design obviates overhanging studs on the connecting rod, and easy and quick manipulation of the machine and changing of stroke are secured by the novel and efficient arrangement of the driving mechanism.

A balanced lever is placed inside the trunk of the machine, and working on each side of it are two driving wheels with large bosses, forming substantial bearings. Into these bosses eccentrics are fitted, which are made fast and loose with the wheels by a strong bolt passing right through them and through the slot in the link or balanced lever. The die block, giving the motion to the lever, is secured on this bolt, so that when the wheels revolve the eccentrics and bolt are carried round with them, giving motion to the lever according to the position of the eccentrics, in relation to the wheels. The adjustment of the stroke is quickly made by loosing the bolt and turning the fly-wheel round until a pointer on the eccentric comes opposite the required stroke, which is indicated on the wheel. Then the bolt is secured, and the adjustment made to the greatest nicety without further trouble. By this arrangement the fly-wheel is brought into the best position for the operator — the driving cone being on the opposite side of the machine, and also whilst large and dangerous driving wheels are avoided, enormous power is obtained by the double train of wheels. Moreover, a very short connection is made, between the driving link and the ram, on which there is no side pressure. The link and connecting rod are in steel with hardened pins and the bearings are bushed where necessary.

*Drummond Brothers (Ltd.)*, Guildford. This exhibit comprised a selection of the firms' small lathes, especially designed for motor repairing. These lathes are fitted with a novel form of slide rest, in the design of which is incorporated a large boring carriage. The loosening of one nut allows the upper slide to be entirely removed, leaving a truly surfaced table fitted with ⊥ slots, converting the tool from a lathe to a regular boring machine for such work to motors as cylinder re-boring, re-bushing gear cases, &c. The most prominent feature of this stand was, however, a fine 9 in. centre 9 ft. gap bed lathe, an extremely powerful tool designed for the use of high speed steels in general manufacturing work, and which has some special points. It has a single pulley headstock, pulley 12 in. diameter carrying 5 in. belt, the belt pull being taken on a separate sleeve clear of the mandrel running in its own bearings. This, with a two-speed countershaft gives fourteen speeds with two open belt speeds of 100 and 200 and 12 through 6 changes of back gear. Only the gears in actual use are engaged when the back gear is in, and the lathe then is working just as the old-fashioned back gear lathe would be, except that the back gears are totally enclosed and run in a bath of oil. There are other improved features calling for notice chief among which is that the slide rails are



HIGH SPEED PLANER. J. BUTLER & CO.

formed at the level of the bottom of the gap and extend right up to the gap space. The saddle can, therefore, be worked right up to the head without any overhang of slide or tool, and no awkward gap piece is necessary. The cross slide is formed as in the smaller lathes; it has a ⊥ slotted boring table of ample dimensions with a sud tray completely round it. There are forty-four screw and feed changes, which are instantly available by moving a pair of levers without changing a gear, but this gear-box is so arranged that any metric or any odd or unusual screws can be cut by extra gear wheels when required. Reversing for screw-cutting or feeding is done at the apron by a side lever always handy to the workman, and so arranged that screws cannot be crossed.

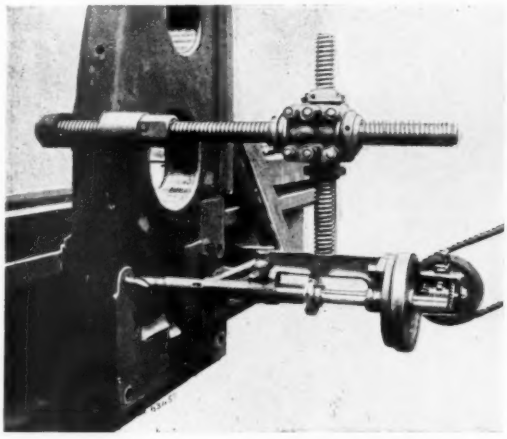
The tail-stock is of new design, fitting the veed edges of the upper part of the bed, giving a truer lateral guide than the ordinary tongue and slot, as the action of fastening brings it hard to these guides as well as down to the flat surface.

The bed is of true enclosed box section, and has cross braces inside the bed diagonal in reverse directions, giving greater stiffness and resistance to the strains it is subject to than the usual vertical cross braces.

In addition to the above tools a small hand lever bench shaping machine was on view.

*George Richards (London) Ltd.*—Not the least interesting model of the many high speed lathes in the exhibition was that staged on this stand, the geared headstock and the patent bed and carriage forming the special features. The bed is protected along its entire length from all turnings and dirt, and its top forms the cover of the slides, and at the same time the side guide of the carriage at the front. It covers the actual sliding surfaces on the bed, and not only protects them from undue wear, but permits of uniform lubrication with clean oil. The fast headstock is an advanced type of the all-gear system. The changes of speeds, sixteen in number, are made by moving a lever, the gears being moved to and fro similar to the method adopted in automobiles. The peculiar feature of the carriage is that it does not touch the top of the bed, and there is a clearance to allow of dust and dirt to pass under the carriage. It is guided by square sliding surfaces under the top member of the bed. Further, it is guided entirely at the front of the bed directly under the tool, and the longitudinal guide is about five times greater than its width. This prevents any tendency to twist when the carriage is moving along the bed, and also reduces the strain on the feed gear wheels and shafts.

Another tool worthy of note was a 20-in.

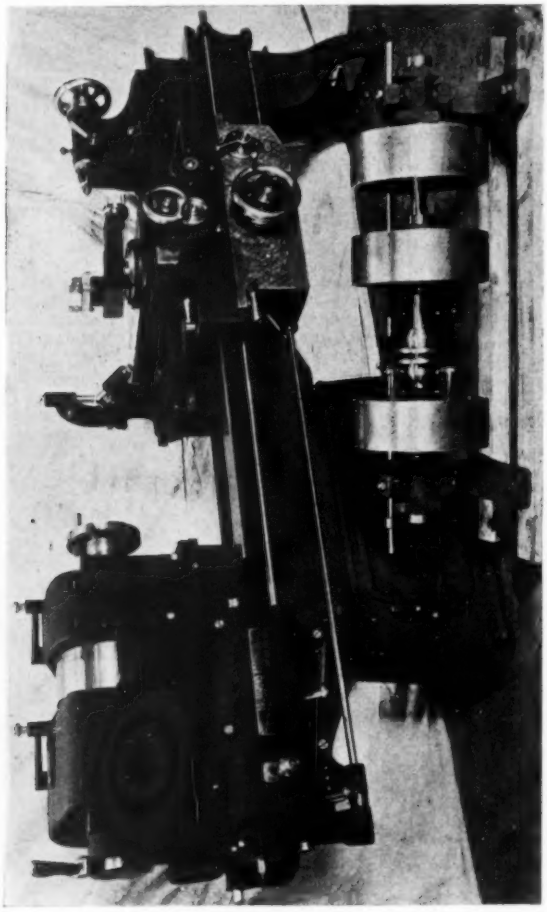


PORTABLE DRILLING AND TAPPING APPARATUS. J. BUTLER & CO.

combined shaper-side planer. This machine combines the features of both types of machines, and, as a shaper, retains one of the principle advantages of the travelling head form. The tables are clamped firmly to the bed, while the tool is fed over the work, instead of as is the case in many small shapers, the table and the work being jerked along at each stroke of the tool to obtain the feed.

The "G. R." key-way system was also shown, consisting of an automatic key-bedding machine, for the preparing the recess in shafts to an exact length and depth for the steel keys of accurate dimensions made by this firm. It should be mentioned that the keys are smaller for their duty that those generally employed, this being rendered possible by the extra shearing strength of the keys and the additional section of metal in the shaft to resist the effect of compression by the key.

Also shown was a "Mitchell" reversing gear apparatus for operating planing machines at high speeds. The underlying principle of this drive is the use of two heavy fly-wheels which distribute their momentum through wide belts at the moment of reversing the motion of the table. The fly-wheels, although revolving in opposite directions, act in unison through the gearing which couples them. The wide belts on the fly-wheels are loose and are alternately pressed on to the driven pulleys by idler or jockey pulleys, and as the belts move in opposite directions they reverse the motion of the lightly constructed driven pulleys, which are attached to the gearing of the machine.

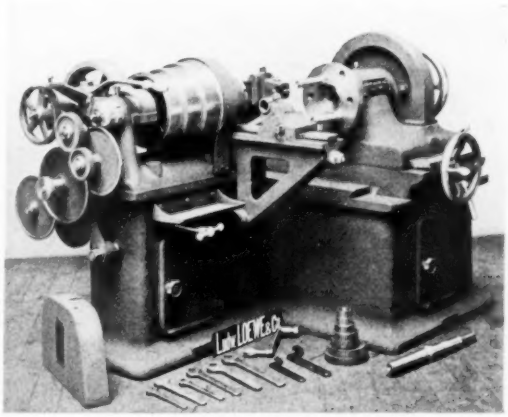


HIGH-SPEED GAP LATHE. DRUMMOND BROS., LTD.

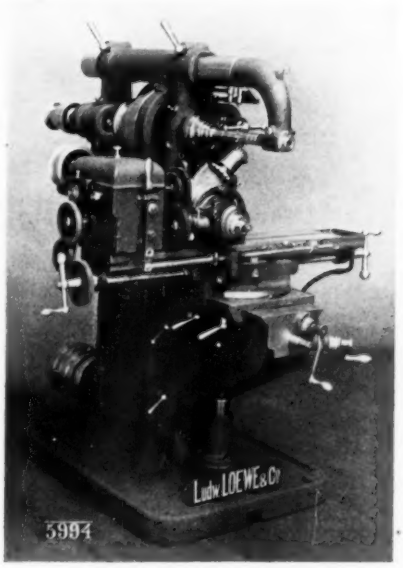
*George Wuttig*, Dresden, represented in this country by Beckenbach & Co., Bradford, staged some interesting machines of new design for cutting screw threads without reversing, and capable of turning out up to twenty-five screws per minute. Whilst in all former screw-making machines the movement of the working spindle and cutter had to be frequently reversed for the purpose of cutting threads, this is no longer necessary in the new machine, in which the spindle and cutter run uninterruptedly in the same direction. This new construction possesses an advantage, in that in cutting threads the movement of the working spindle need never be reversed nor arrested, and in that the shaping tools can uninterruptedly work simultaneously with the cutter. The threads can thus be cut simultaneously with the making of the pivots or cutting off, without any necessity for this work to be done separately. The shaping tool, resting on a special slide, can be moved, according to requirements, either diagonally to the spindle, or in the same direction as the spindle, or in both directions simultaneously, whilst the cutting-off tool arranged on the opposite side works

independently. A third tool which can be used in shaping the screw-head, or cutting off the contact-surface of the screw-head, or cutting a hollow space in the end of the cutter, or receiving a small milling wheel is arranged likewise in a way to enable it to work independently over the cutting-off tool. If the machine is only to be used for making hollow articles without threads, the cutter can be replaced by a drill-holder. If desired, the machine can also be supplied with a special boring device, for the purpose of boring as well as thread-cutting.

*Ludw. Loewe & Co., Ltd.*, Clerkenwell.—Among a representative display of tools on this stand were two of more than usual interest. The first was a circular milling machine, 23½ in. by 7⅞ in., for internal or external work, of entirely new design, its function being to take the place of the lathe for work of such forms as can be produced by milling cutters; as for example:—gear wheel blanks either spur or bevel, grooved pulleys, hand wheels, flanged pulleys with crowned face. The cutter spindle is of steel, and is provided with a drawback bolt for the cutter arbor. It is driven by back gears having a ratio of 1 : 7. The outer end of the cutter arbor is supported by a movable tailstock which must be taken away before milling internally. The cutter and the work are brought to a standstill simultaneously at each complete revolution of the latter by means of an automatic stop. The head which carries the work spindle, is adjustable in both directions horizontally. An adjustable stop is provided which ensures the head being brought back to exactly the same point for each piece of work, when milling parts of equal diameter. The work spindle is driven by a worm gear which can be disconnected and the spindle directly revolved by a hand wheel. Changes of feed are made by means of change gears and an arrangement is provided by which a constant rate of feed is maintained for all diameters of work, provided that the diameter of the cutter remains the same. The outboard bearing supporting the outer end of the work arbor is carried on a knee which can be swung aside when putting in or removing the work.

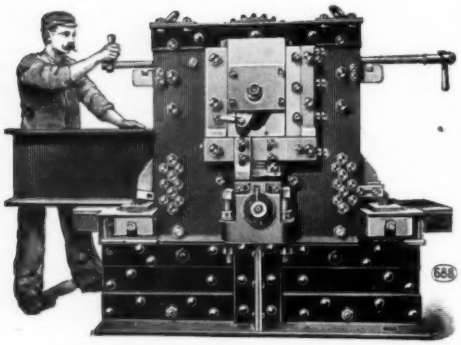



CIRCULAR MILLING MACHINE. LUDW. LOEWE & CO.




AUTOMATIC INDEXING APPARATUS. LUDW. LOEWE & CO.

The other novelty was an automatic indexing apparatus for attachment on a universal milling machine, whereby the latter is converted to an automatic gear cutter without affecting its utility as a universal mill. When once adjusted, the apparatus automatically and accurately controls the division, and also the advance and quick return of the table. The general appearance of the apparatus is that of an enclosed gear box, which is attached to the table next to the dividing head, to which it is connected by a train of wheels, while a further train on the opposite side operates the table feed. The apparatus is driven by a belt from the counter-



DOUBLE-ENDED NOTCHING MACHINE. HENRY PELS.

shaft, and any existing feed-driving arrangements must be disconnected.

The automatic feed of the table with quick return is brought about by means of the change wheels mentioned, which connect the apparatus with the table feed, and the ratio of these change wheels determines the amount of feed per revolution of the work arbor. The return speed of table is eight times that of the working. The travel of the table is regulated by adjustable dogs which are attached to a horizontal bar, and strike against a fixed stop. The bar is connected to the reversing lever in such a manner that by simply changing the position of a screw, the direction of feed and return respectively can be reversed, enabling either right or left hand cutters to be used. The automatic division takes place at the end of the return motion, the driving wheel of the train between the apparatus and the dividing head making exactly one revolution each time. The apparatus can only be used on a machine provided with a dividing head and change wheels, and is intended for work which does not require to turn while the cutter is in operation. The spindle of the dividing head can be arranged horizontally, vertically, or tilted to any desired angle. The apparatus can be attached without trouble to most universal milling machines.

*Henry Pels & Co.*, London, W.C. This proved to be one of the most attractive stands in the exhibition by reason of the frequent demonstrations which were given of cropping, notching, and shearing steel sections by the machines forming the specialty of this firm. Five types were shown, three of which we select for illustration. The first is a "John's" patent double-ended notching machine, and capable of notching joists from 4 in. by $1\frac{3}{4}$ in. up to 16 in. by 6 in., and channels from 4 in. by $1\frac{3}{4}$ in. up to 15 in. by 4 in. This machine appeared to be exceptionally useful for doing such notching work as is necessary in the case of steel underframes for carriages and wagons, or in constructional steel work of any kind. The machine worked with the greatest rapidity, giving at the same time a very high finish.

The second machine illustrated is a "John's" patent splitting shear. This machine is capable of splitting plates of any length and width up to $\frac{7}{8}$ in. thickness, right across the centre, and differs so far from the existing shearing types with open gaps, as it will allow of the cross cutting of plates of the largest dimensions.

Two croppers were shown, the first of which is capable of cropping the following bars without change of blades: Round bars up to $2\frac{1}{4}$ in.; squares up to 2 in.; flats up to 3 in. by $1\frac{1}{4}$ in.—6 in. by $\frac{5}{8}$ in.; angles up to 5 in. by 5 in. by $\frac{1}{2}$ in.; tees up to 5 in. by 5 in. by $\frac{1}{2}$ in. In addition, it is also provided with another cutter at the bottom for cropping channel bars up to 6 in. by 3 in. by $\frac{5}{16}$ in. by $\frac{7}{16}$ in., which latter blades are, however, easily interchangeable for inserting others to deal with any other rolled steel sections. The machine was driven by a $2\frac{1}{2}$ h.p. "Westinghouse" motor carried on the top of the frame, thereby making the whole fully self-contained.

The other cropper shown is particularly suitable for constructional engineers, and was driven by a $4\frac{1}{2}$ h.p. "Westinghouse" motor, also fitted on the top of the machine. This machine is capable of cropping on the square: Angles up to 6 in. by 6 in. by $\frac{5}{8}$ in.; tees up to 6 in. by 6 in. by $\frac{5}{8}$ in.; round bars up to $2\frac{1}{2}$ in.; square bars up to $2\frac{1}{4}$ in.; flat bars up to $3\frac{1}{2}$ in. by $1\frac{1}{2}$ in. – 7 in. by $\frac{3}{4}$ in. On the bevel to any angle from 45 to 90 deg. left and right hand: Angles up to 5 in. by 5 in. by $\frac{5}{8}$ in.; tees up to 6 in. by 4 in. by $\frac{5}{8}$ in.

This exhibit was completed by a joist shear, capable of cutting as follows: Joists from $5\frac{1}{2}$ in. by 2 in. up to 16 in. by 6 in.; channels from 6 in. by $2\frac{3}{4}$ in. up to 15 in. by 4 in.; angles up to 6 in. by 6 in. by $\frac{3}{4}$ in.; zeds from $5\frac{1}{2}$ in. by $2\frac{1}{2}$ in. by $\frac{3}{4}$ in. up to 10 in. by 3 in. by $\frac{5}{8}$ in.; tees up to 8 in. by 6 in. by $\frac{3}{4}$ in.; bulb plates up to 12 in.; bulb tees up to 9 in. by 5 in.; bulb angles up to 11 in. by $3\frac{1}{2}$ in. This machine, which was driven by an 11-h.p. "Westinghouse" motor, executed the various operations in very rapid manner, the clean cutting of rolled steel sections being particularly noticeable.

The hard wear and tear to which machines of this type are generally submitted calls for great strength and rigidity both in the frames and moving parts. This is secured, without involving undue weight and large floor space, by using steel throughout.

*Collett & Engelhard, Ltd.*, Offenbach, showed a travelling electric drilling and tapping machine and a portable radial drilling machine. The former machine can be easily transported and put into use at the desired place without any preparatory work, and in drilling holes of small and medium diameter the weight of the machine

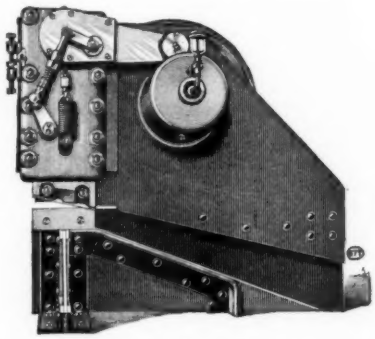
affords sufficient stability. For drilling larger holes, and when the head works at the top of the column, the stability of the machine is secured by two arms attached to the base plate. The carriage is fixed on the ground by means of four strong disc screws. The drilling spindle is driven by an electric motor of 2 h.p. through a double threaded worm gear and spur-wheels, which can be put in and out of gear and enable the machine to work at four different speeds. The head can be turned round its horizontal axis, through 360 degs. on the column, which can be moved horizontally on the carriage. The second machine, which is driven by a 3 h.p. motor, is equally handy, and can be used for drilling holes in all positions, the drill spindle being adjustable in every direction for the purpose.

*Pfeil & Co.*, Clerkenwell.—A full list of the Reinecker machines shown on this stand has already been given in the preliminary notice in the previous issue. Mention may, however, be made of the full-automatic bevel gear "Bilgram" planer, which operates without template or former. The reciprocating planing tool has straight flanks inclined to each other at an angle of 30 in., and the blank to be cut is given its correct rolling motion across the tool path. The tooth flanks produced are correctly curved and very smooth, as the tool cuts with its flank and not with the point as in template copying machines.

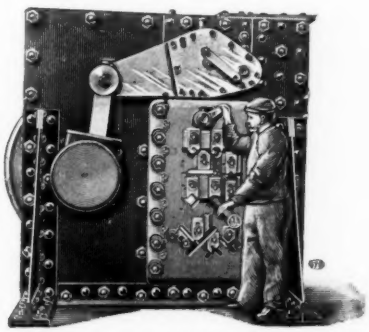
*H. M. Budgett*, Chelmsford, showed a variety of surface specialties, amongst which may be mentioned some surface plates furnished by an automatic process and guaranteed not to vary from the mean surface by more than $\frac{1}{50000}$ in. at any point. Others for ordinary shop use were displayed in which a variation of not more than $\frac{1}{10000}$ in. from the mean is guaranteed. Also shown was a range of cast-iron straight edges finished in the same way as the higher grade surface plates, ribbed and designed as shown in the illustration; tribars for truing up the gibs of machine tools; parallel strips accurate to within $\frac{1}{1000}$th in. The latter are for use on the beds of machine tools, on setting-out plates and for setting callipers. Vee blocks of the ordinary patterns were also displayed.

*Craig & Donald, Ltd.*, Johnstone, had a new type of plate flattening machine in operation, working steel plates up to 5 ft. wide by $\frac{3}{8}$ in. thick. For this machine, which uses only four rolls, an increased efficiency is claimed over the old mangle or seven-roll type, besides occupying less floor space and being easier manipulated. The flattening is obtained by regulating the height of the top straightening roller, which is 6½ in. diameter, in relation to the others. For bending work three rollers are utilised, the top bending roll being 9 in. diameter. The latter has independent adjustment for each end, so that if a plate, which is being rolled, has one side longer than the opposite side, the shorter side can be drawn by pressing the roller harder on this side, thus aiding materially in taking the buckle out of thin plates. When thin plates are very badly buckled, it has not been possible hitherto to thoroughly flatten such plates without first slightly hammering them; but it is claimed that with the new machine better results are obtained than with equal sizes of other types.

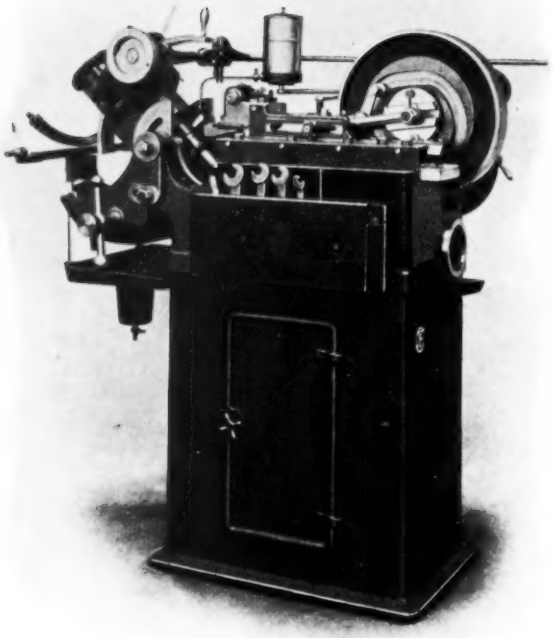
In another type of machine, of which a scale working model was shown, the small side top or straightening roller is, when being used for bending, run down into position in sliding guides by worm gears and screws until its top edge is on a level with the tops of the bottom rollers, the roller acting as a shelf in feeding the plates into the machine. When bending the top half of one of the checks is capable of being swung aside to enable the complete rings to be removed from the top roller. When the top straightening roller is run up into position the machine is then used as a straightening machine only. The plates in this type of machine can be severely dealt with by pressing down the top bending roller over the plate to be straightened, so that when the plate passes through the rolls it gets a severe curve; and in running the plate back under the straightening roller, which has been set to bring the plate



SPLITTING SHEARS. HENRY PELS.



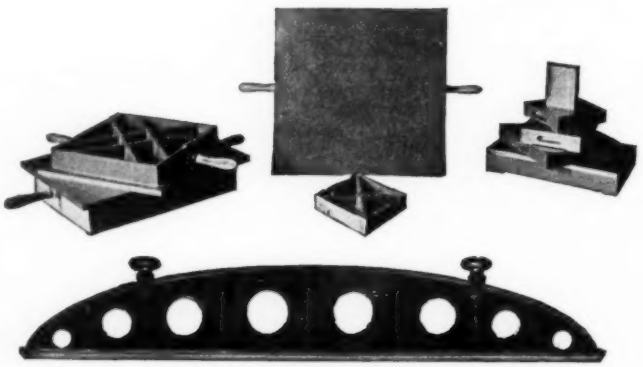
BAR, ANGLE, AND TEE CROPPER. HENRY PELS.



FULL AUTOMATIC BEVEL GEAR "BILGRAM" PLANER. PFEIL & CO.

level, the curve which has been given to the plate is removed, and all ordinary buckles, unless in the thinner plates, are taken out of the plate with one pass. The top bending roller is arranged to be raised and lowered at each end independently, so that when a plate, with one side longer than its opposite, has to be straightened, pressure can be put on the short side, and in this way, the plate is "drawn" on the one side. In shipyard practice, when the machine is used for bending purposes, in the event of a plate being over-set, it is not necessary to take the plate out of the machine to remove the "over-set," as the straightening roller can be run up into position, and the plate flattened out and re-set.

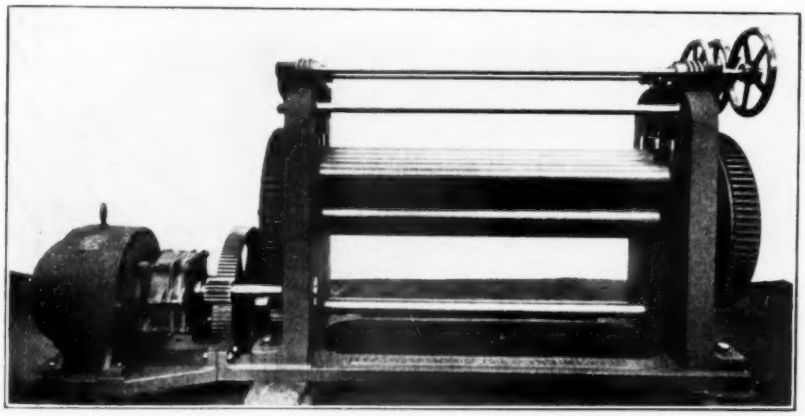
*Greenwood & Batley, Ltd.*, Leeds, staged the only turbine in the exhibition. It was a 5 b.h.p. "De Laval" type, coupled to a dynamo, but was not running. The feature of this stand however, was an 8-in. automatic bevel wheel shaping machine, which we illustrate. It is arranged to automatically shape and divide the teeth of bevel and mitre wheels from an enlarged copy, or former. The cutting tool is carried by a reciprocating arm, and is provided with horizontal, vertical and swivelling adjustments to the tool box. The work spindle carrying the wheel to be cut, the worm wheel and dividing apparatus are mounted upon the smaller of two superimposed swivelling sectors, which pivot on a common centre, this centre being arranged to coincide with the point of the cutting tool. The smaller sector is adjustable upon the face of the larger sectors to suit



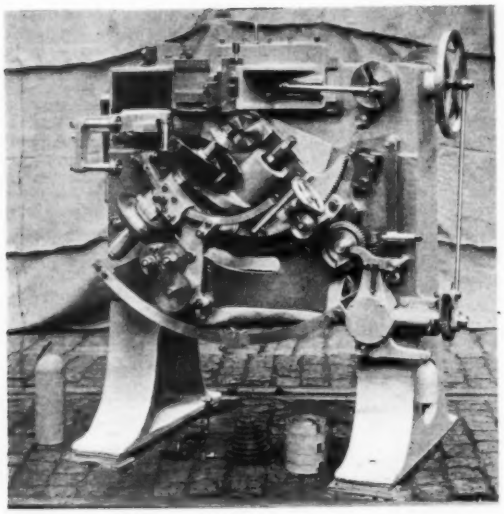
SURFACE PLATES AND STRAIGHT EDGE. H. M. BUDGETT.

the angle of the wheel which is being operated upon. The headstock and socket carrying the mandril and the dividing apparatus are adjustable for various diameters of wheels, and attached to the socket is a radial adjustable arc lever, upon the extreme end of which is fitted the copy or former, which latter is kept in contact with a hardened steel guide plate by means of a hanging weight and cord passing over guide pulleys. The action of the machine is as follows: The wheel mounted upon a mandril is fed upwards towards the reciprocating tool by the movement of the larger sector, which is actuated by a pinion engaging in teeth cut in its periphery and driven through a worm and wheel by means of hand gearing and ratchet feed motion. At the same time the spindle carrying the wheel is receiving a variable axial motion, imparted to it by the copy or former. When the correct depth of tooth is arrived at, the feed is automatically tripped and the sector returned to its original position by means of a weight. During this return motion the wheel is automatically divided by means of the friction driven change gear, the cam controlling this motion being tripped by an adjustable stop. The feed is then automatically re-engaged and the cycle of operations continued until the wheel is finished and the machine is stopped by the operator.

*Kendall & Gent, Ltd.*, Manchester. Of the machine tools shown by this firm we may particularise a fine universal cutter and tool grinding machine which embodies several new features. In addition to the main spindle there is provided a high-speed spindle on a vertical slide carrying an emery wheel. This spindle, which is the one most generally used, is driven by belt from the main spindle, and being capable of a vertical motion by hand-lever, enables several varieties of work to be performed that cannot be done on ordinary machines. The sliding surfaces to the main and swivelling top tables are carried up into the body of the main table and are thus out of the way as much as possible of emery dust, and are not therefore subject to the wear that is usually found at this part. The traversing of the tables and a heavy cutter past the emery wheel is performed by a quick-pitch screw and handle. At the same time, as it is frequently desired to use this screw as an adjustment, or for setting on cut, it is also arranged with a portion having a fine pitch, either of these pitches being available by slackening or tightening a thumbscrew. Due to the adaptability of the machine as a whole the plain and substantial indexed heads supplied with the machine suffice for almost all operations required in the tool room, a special fixing, fitting the standard swivel head, is, however, supplied for sharpening formed gear cutters. In this the cutter is supported on a spindle fitted with a notched disc and plunger, correct dividing is thus secured giving equal tooth height to the cutter, and a true radial face giving correct tooth form in the cut wheel. A second barrel or support having an extra large hole to accommodate the taper shanks of large cutter heads is also supplied. The machine is fully indexed where necessary, and has a micrometer stop to the vertical slide for use either with hand-lever or screw. The machine is provided with an annular face-grinding wheel in a protecting iron case on the main spindle, and is fitted with a hand rest for the hand grinding of small tools, flat drills, &c. The hand rest can be removed and an ordinary twist drill grinding fixture secured in its place when desired. A vertical slide enables the machine to be used for sharpening cutters having a curved outline either convex or concave, a suitable former being used.



BENDING AND STRAIGHTENING ROLLS. CRAIG & DONALD.



AUTOMATIC BEVEL WHEEL SHAPER. GREENWOOD & BATLEY, LTD.

*The Colchester Lathe Co.*, Colchester, showed several standard high speed lathes, some of which were in operation. The 7½-in. special pattern machine, which is illustrated, was doing some very heavy cutting, reducing a 4-in. steel bar to 3 in. at a single cut. This high cutting capacity is rendered possible by the high belt speed adopted—the countershaft running at 500 revolutions per minute—and by the broad cone pulley. The latter is arranged so that it always runs loose on the spindle and drives a shaft running parallel to it, the spindle being connected with this shaft by a nest of sliding gears, no idle gears being in mesh. The wheels are thrown in and out of position by the handwheel shown above the casing. The hollow spindle is bored to admit a 2-in. diameter rough bar and is fitted with ball thrust. The saddle is very heavy, with long bearing surface. It is of sufficient length in front of the bed to enable the largest diameter of work to be faced with one setting of tool. The rack and pinion are of steel, and the self-acting sliding motion is put in and out of gear by a small lever conveniently placed in front of the saddle. The self-acting feeds are positive, and are reached by gearing from head-stock to backshaft, and can be instantly changed by means of a lever placed in front of the bed within easy reach of the operator.

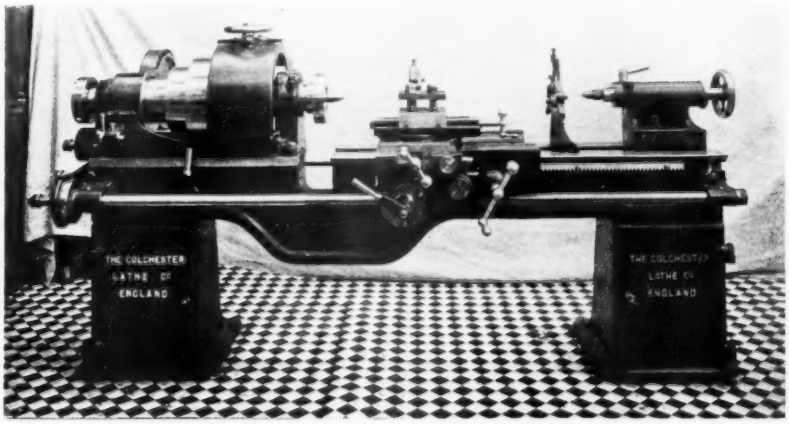
*Cunliffe & Croom, Ltd.*, Manchester. A self-contained motor driven planer-type milling machine was conspicuous on this stand, machining the halves of aluminium crank cases and gear boxes, as required in automobile work, for which it has been specially designed. The machine may, however, be suitably geared for general requirements. It is of the vertical spindle type, the spindle slide having a self-acting feed horizontally in both directions along the cross slide with an auto-trip to each traverse. The latter is 2 ft. 6 in. The table, which is 5 ft. in length, has also a 5 ft. auto-traverse and trip motions in both directions.

A motor-driven self-contained planing machine, 2 ft. 6 in. by 2 ft. 6 in. by 6 ft., was also shown. It has an unusually deep bed and is provided with a four-speed gear box, the speeds of which are controlled by means of one lever only. The feed motion is so arranged that a cut can be put on at either end of the stroke, and any alteration from a fine traverse to a broad cut can be made whilst the machine is running.

UNIVERSAL CUTTER GRINDING MACHINE. KENDALL & GENT, LTD.

Other items comprising this exhibit were 20 in. and 30 in. vertical turning and boring mills, plain milling machines, drilling machines, and two disc grinders.

*Humpage, Thompson & Hardy*, Bristol. This exhibit was restricted to two automatic gear hobbing machines, one of 30 in. and the other 14 in., both electrically-driven and doing useful work cutting spur wheels for actual service. Both machines are on usual general lines, but a number of improvements have been embodied in the design. Foremost among these is the variable feed gear which gives any desired rate of feed to the hobbing cutter. As will be seen from the illustration of this detail, this gear consists of a pair of taper cones with a moving belt running in conjunction with an epicyclic train. Automatic stops are provided, and the slide




7½ IN. HIGH-SPEED GAP LATHE. COLCHESTER LATHE CO.

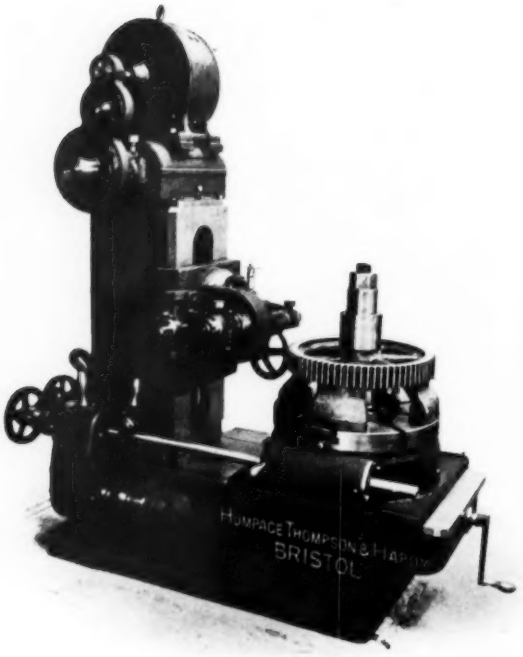
which carries the hob bracket can be raised or lowered by means of the hand wheel while the automatic feed is on. Another feature relates to the method of setting the cutter, which is effected by a circular gauge plate conveniently arranged on a hinged arm attached to the sliding saddle above the hob.

The first drive is from a shaft running at constant speed through a four-speed gear box carried on top of the column. Change of speed is effected by an ingenious key arrangement whereby any one of the four wheels is engaged with the constant speed shaft. Motion is transmitted from these wheels to the countershaft gearing, thence to the vertical shaft through bevel wheels. The machines, as will be seen, are very stiffly built and will cut big pitches in steel at a high speed. For example, the 22 in. machine will cut up to 3 pitch in steel at a rate of 4 in. of tooth per minute, and the 16 in. machine will cut 4 pitch at a rate of 3 in. per minute.

The 30 in. machine shown has cut a steel pinion 12 teeth 2 pitch ($1\frac{5}{16}$ circular pitch) $3\frac{1}{2}$ in. face in 54 minutes; in cast iron 30 minutes, with a carbon steel hob. This was the original machine made by the firm, and the first trial wheels cut on this machine were exhibited.

*Macdnald, Adamson, Swinburne & Co., Ltd.*, Glasgow. An interesting tool figured on this stand in the shape of a universal grinding machine without overhead gearing. This unique feature permits of heavy work being swung into the machine from any position. The method of traversing the emery wheel and not the work is adopted, the head and tailstock being clamped firmly down. The drive is under the emery wheel slide, and the latter can traverse the bed with freedom since there is no drum along which the slide has to drag the belt. A swinging gap bed is provided, thus enabling eccentric rods, piston rods with butts, or piston rods with piston in position being ground, or the piston being tapered without special attachment.

*Joshua Heap & Co., Ltd.*, Ashton-under-Lyne, had a representative show of their screwing and tapping machines, which, however, they were unable to run owing to the views of the British carpenter as to the nature of a flooring. There was a 4-in. "Rapid Grip" screwing and cutting machine for screwing and cutting tubes and making nipples. This machine is fitted with a special chuck for gripping the tubes without stopping the machine, thus saving the time of stopping and screwing up and unscrewing the gripping jaws as in the ordinary machines. The screwing dies are adjustable, and




HIGH SPEED GEAR HOBBER. HUMPAGE, THOMPSON & HARDY.

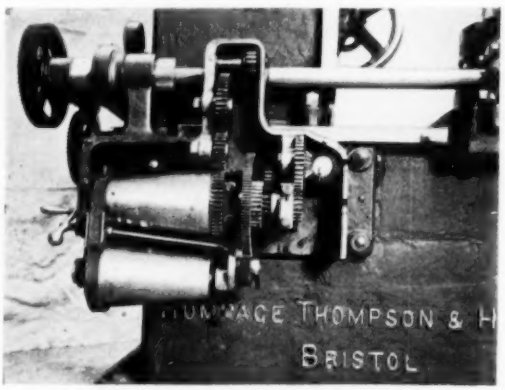
can be instantly opened, thus allowing the tubes to be withdrawn after the thread is cut, without stopping or reversing the machine. The cutting-off arrangement is conveniently placed at the back of screwing head; a pipe can be alternately screwed and cut without removal from machine, the screwing head sliding away after use.

When making nipples the tube is first screwed, after which the screwing head slides away. Two stay jaws are then brought in position for supporting the tube whilst cutting, which is done by two parting tools worked by a right and left-hand steel screw with adjusting motion for equalising the cutting of each tool.

Another noteworthy tool was a 2in. bolt screwing and nut tapping machine with a four speed cone pulley. The driving is so arranged that the machine can be run either single speed or through gearing, thus giving a considerable range. The dies are of the chaser type and the screwing head is fitted with a releasing motion for instantly opening the dies.

*Mayer & Schmidt*, Offenbach.—The application of grinding was well demonstrated by this exhibit, which comprised a cylinder grinder, twist drill grinders, and several universal and automatic grinding machines. The cylinder grinder was one of the largest the firm manufacture, and is capable of grinding cylinders up to 300 mm. diameter and 1 m. in length. It is of the horizontal type, working automatically. The work is not rotated, but fixed to an adjustable table. The grinding spindle rotates both on its own axis and eccentrically with a planet motion, and a dust exhausting device serves the double purpose of keeping the cylinder both clear and cool.

*Schuchardt & Schutte*, Westminster, had three stands, that in the centre of the hall being of novel design. Their collection included several high-speed lathes, with all-gear head stocks, a full range of "Prentice" tools, including the latest type of turret lathe, with all-geared head stock. The firm's automatic gear hobbing machines are once more to the front, the No. 2 size being shown in operation. The No. 4 machine had a No. 0 machine placed on its table, the three machines together making a very effective display. Of other machines in operation special mention




DETAILS OF FEED GEAR ON THE HUMPAGE, THOMPSON & HARDY HOBBER.

may be made of a "Lundis" screwing machine and a crank-shaft lathe. A three-spindle turret drill represented a novel departure in multiple drilling machines, while special mention may be made of a 6-in. general tool-room lathe. The firm's specialties for motor manufacturers included two novelties — one, an automatic machine for producing castellated gear box shafts; the other, a patent cam grinding attachment. The "Initiandum" tool-holder deserves mention as a useful appliance for repetition work.

We should have been glad to illustrate several of these tools, but for the fact that our applications for photographs were received with an inexplicable lack of courtesy.

*The Lumsden Machine Co., Ltd.*, Gateshead, staged a combined disc and emery grinder, and a semi-automatic lathe tool grinder, and the *Smith Slotting Machine Co., Ltd.*, had one of their machines in operation. The latter has already been described at length in a recent number of the ENGINEERING REVIEW.

Mention should be made of the variety of small tools displayed by *Arnold Schove*, London, E.C., amongst which may be mentioned two hack-saws. These are fitted with a patent swivel slide, imparting to the saw a rocking motion enabling the cuts to be made with great rapidity. There was a new departure in the shape of a circular cold saw, and the universal tool grinder and twist drill grinders were examples of neat and useful tools.

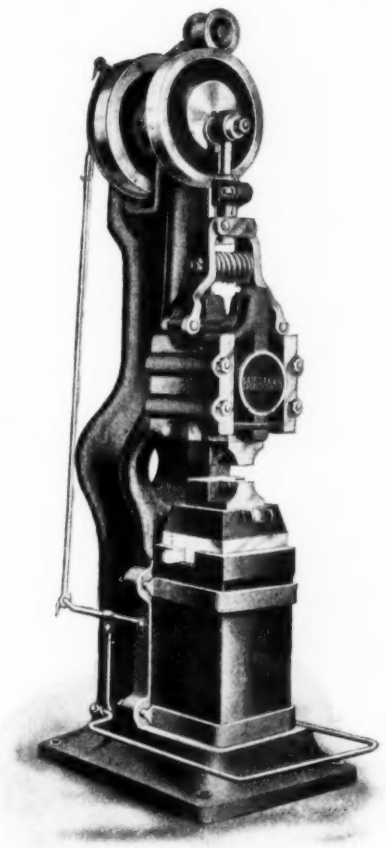
*Messrs. Beanland, Perkin & Co.*, Leeds, staged hack sawing machines, a twist drill grinder, and a wet and dry tool grinder.

We may conclude our report of the machine tools by an allusion to a simple and well-designed power hammer shown by *The Fairbanks Co.* The hammer is operated by an adjustable crank, the crank-pin sliding in a groove in the crank disc, allowing the operator to lengthen or shorten the stroke at will. Motion is applied to the head or ram by means of a connecting rod, to which is secured a cross-head having a split sleeve, and to this cross-head are hinged two side-arms, these in turn being directly connected to the ram by links. By the use of a steel spiral spring, the force and weight of the blow are many times multiplied, but with an elasticity that removes danger of breakage, and, at the same time, the jar is so cushioned that it is not noticeable in the machine when the blow is struck. The head strikes a quick, sharp blow, and instantly gets away from the work, thereby avoiding any chilling of the stock.

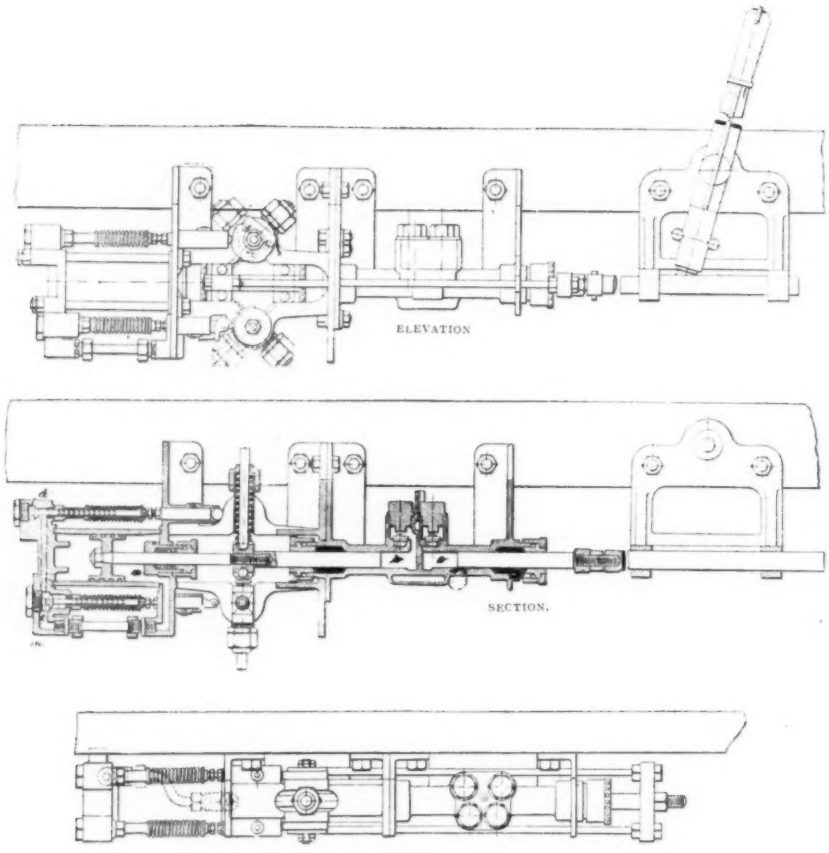
## PUMPS.

Second only in importance to the machine tools were the pumps, of which a great variety was shown, especially of the vertical and horizontal boiler feed types. *The Albany Engineering Co.*, London, S.E., showed their patent water-sealed rotary pump, specially adapted for forced lubrication and for boiler feeding. The pump shown working, was pumping against a pressure of over 200 lbs. per sq. in., and a noticeable feature was the constant delivery when running at very low speed. As the pump has already been described and illustrated previously in the ENGINEERING REVIEW it will suffice to observe that the most important feature is the fact that slips and leakage are claimed to have been eliminated by the introduction of groove cuts along the face and edges of the teeth, so that in rotating, a body of water lodges in the grooves forming a sealed water-tight joint or cushion between the casing and the rotating rollers, thereby producing an efficient vacuum. Centrifugal force also adds an amount of efficiency to the pump.

*Clarke, Chapman & Co., Ltd.*, Gateshead, exhibited a pair of direct-acting, slow-speed



POWER HAMMER, FAIRBANKS CO.




DOUBLE-ACTING FEED PUMP—SHEPPEE MOTOR CO.

feed pumps fitted with the "Woodeson" steam thrown valve gear, each pump of the pair being capable of dealing with the feed water for 1,400 i.h.p. engines. The valve gear is of the Corliss type, and consists of two small auxiliary valves and one main distribution valve, and, unlike most other valve gear where the auxiliary valves alone are positively moved, the whole of this gear, including auxiliary and main distributing valves, is mechanically moved before the main valve is given its final movement by the action of the steam. This, it is claimed, enables the steam to be used most economically by reducing the area of the steam port during the travel of the piston, and this period closing of the main steam port allows the pump piston rod to slow up at the ends of the stroke, and so eliminates shock in pipes. No valve setting is required, as it is impossible to put this valve gear together in any other but the correct way. A duplex feed and ash ejector pump of a particularly strong pattern was also shown.

*The Pulsometer Engineering Co., Ltd.*, Reading, had one of the most striking stands in the exhibition, perhaps the most striking for its size. They showed one of their No. 12 pulsometers, a pump which, although only 10 ft. 6 in. high, is capable of throwing 150,000 gallons per hour. In order to emphasize the great range of pumps that the company make, there was shown a No. 1 pulsometer pump in close proximity to the No. 12. This little

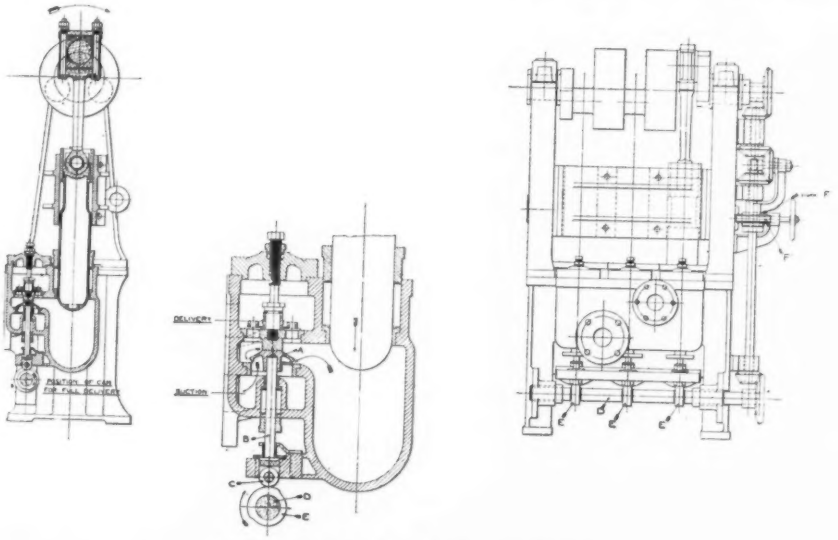
pump, which is only 17 in. high, has an output of 1,000 gallons per hour.

*W. H. Bailey, Ltd.*, Salford, showed horizontal and vertical types of a direct-acting steam pump, the feature of which is the range of speeds at which it can be driven, viz., from one or two strokes up to 300 per minute. There was also a three-throw ram pump, suitable for house water supplies, capable of dealing with ten gallons per minute.

Much attention was directed to the exhibit of the *Sheppee Motor Co.*, York, consisting of a double-acting feed pump for use with flash boilers or other generators using highly superheated steam. Its details, which embody several novel features, will be understood by the aid of the accompanying drawings. The pump is of the direct double-acting type, the steam piston and water rams being in the same line, but it also combines certain qualities of the crank and fly-wheel variety. This is accomplished by the use of two powerful compensating springs, suitably arranged at right angles to the piston rod.

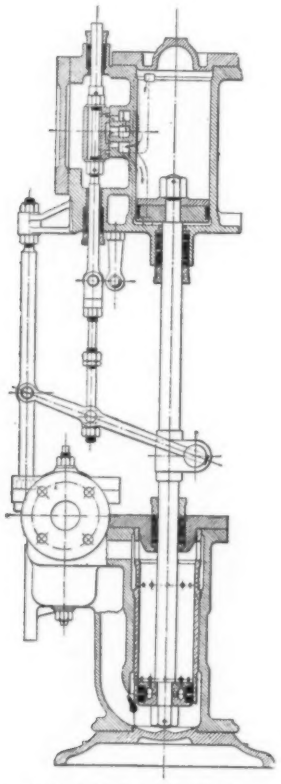
The valves that control the admission and release of the steam to the cylinder are four in number, of the simple mushroom type, held against their seats by spiral springs, each valve being contained in a separate valve-box with screw-cap. It will also be noticed that glands are entirely dispensed with, the long grooved valve stems passing through sleeves.

The cylinder, which is a plain casting, turned to an even thickness throughout its length, is held in position by four long bolts, running the whole length of the cylinder, passing through the cover at either end, and secured by nuts The piston has four rings of the usual type, being made especially deep. The back cover of the cylinder, as will be seen, is unique. It contains the valves for both ends, besides all the parts and passages through which the steam passes: in fact, it takes the place of the steam chest in the ordinary type of steam cylinder. Underneath the cylinder is a pipe through which the steam both enters and leaves. This pipe or port actually opens into the cylinder cover, rapidly freeing itself of water when just starting. By this method of arranging the valves the stems are able to pass through long sleeves all pointing in the same direction, and of the same length, which is a great convenience. The front end cover is formed by the end of the compensating frame, which also contains the stuffing box and gland. The compensating frame is a novel departure in feed pumps, and contains the compensating attachment, also the various mechanism for operating the four valves in the back end of the cylinder. The compensating attachment is composed of two spiral springs, mounted in pockets which turn on trunnions, set at right angles to the piston rod. The ends of the springs butt on tee pieces, attached to the guide passing up through the centre of the spring, which in turn is bedded in grooves in the top and bottom of the cross-head. The pockets are capped by large nuts against which the ends of the spiral springs rest. As the cross-head travels backwards and forwards this spring performs an oscillating motion on either side of the piston




3-THROW VARIABLE DELIVERY PUMP. THWAITES BROS.

rod, the trunnions working on fixed centres. The cams for opening and closing the exhaust valves are fixed tight, one on each end of the lower trunnion, while the cams for operating the steam valves run loose on bushes through which the top trunnion passes. To open the steam valve a striker is attached to the end of the top trunnion, which, in oscillating, raises the cam against a ball which in turn forces the valve open; on the return of the stroke the cam is released and the valve closes. This all takes place in a horizontal line without the intervention of any pins or knuckle joints, and is of exceedingly simple design. The exhaust cam opens its valve in much the same way, only it is attached firmly to the trunnion end, and works against a trigger which opens the valve in one direction of the trunnion but not in the other. A small pin in the cam is also provided for opening the exhaust at the end of the stroke before the triggers are able to hold the valve open. Small spiral springs are attached to the cams and triggers to keep them in their places. The type of pump shown will deliver about 30 gallons per hour, using steam at 600 lb. pressure, while the pumps are tested up to 1,000 lb. pressure.



VERTICAL DIRECT-ACTING FEED PUMP. THWAITES BROS.

*Thwaites Bros., Ltd.*, Bradford. Of a miscellaneous exhibit comprising several Roots' blowers, a steam hammer, air compressor, enclosed type vertical engine and pumps, the latter are selected for description by reason of their conspicuous interest. The first was a variable delivery three-throw pump, with constant stroke and speed, driven by a "Phœnix" motor through reducing gear. The method of regulating the quantity discharged from zero to the full capacity will be obvious by reference to the sectional illustration on page 339. Beneath each suction valve, *A*, there is a spindle *B*, the end of which carries a hard steel roller, *C*. The cam shaft, *D*, carrying the cams, *E*, is driven direct from the crankshaft by a train of bevel gears. The angularity of the cams can be varied in relation to that of the crank pins by means of the worm and worm-wheel, *F* and $F^1$, actuated by the hand wheel seen to the right. This adjustment can of course be made whilst the pump is standing or in motion. By this adjustment the spindles, *B*, are held up, and keep the suction valves open in turn during the whole or any required portion of the stroke of their respective plungers. By this means the delivery can be varied from nothing to full capacity, the power absorbed being in proportion to the quantity delivered as the water not delivered merely passes back through the suction valves at no pressure instead of being forced up through the delivery valves.

The other pump shown was of the vertical direct-acting type and is also illustrated in sectional elevation. It will be seen that the valve is of the simplest type and is reciprocated by a rocking lever attached to the cross-head, the action thus depending directly on the motion of the piston rod, and, as a consequence, is under complete mechanical control. In addition to the simplicity of action thus obtained, another feature of this pump is the method of overcoming the neutral point in the steam valve. A number of small ports are drilled in the top and bottom of the pump liner, these ports being so placed that there is direct communication between the two sides of the pump piston when it is at the top or bottom of its stroke. It is when the steam valve is in the neutral position that these ports begin to open, with the natural consequence of destroying the pressure in the pump cylinder and enabling the steam in the steam cylinder to expand and complete the stroke. The completion of the stroke necessarily means that the steam valve is carried over into such a position that steam is admitted into the opposite end of the cylinder. The amount of opening of these ports can be readily adjusted by the nuts on the valve spindle, and can be permanently fixed,

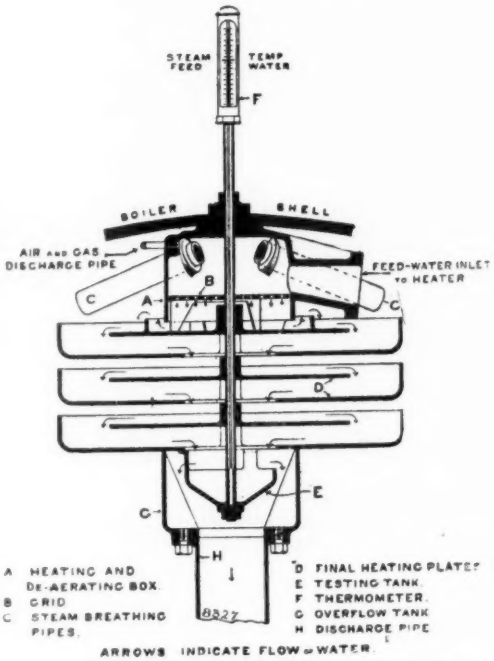
so that there is no fear of sticking at any speed at which the pump may work. The pump was shown working, and a very regular flow was noticeable, due to the absence of any slowing down at the end of the stroke.

*P. F. Oddie*, London, S.W. On this stand were exhibited several types of "Oddesse" pumps, two of which were shown at work. The distinguishing feature of this pump is that the motion of the valve gear is obtained without the use of rocking shafts or joint pins, the slide valves being driven by inclined blocks which have the same motion as the piston rod, being attached thereto by a projecting arm. These sliding blocks and slipper-pieces are of cast iron and being lubricated by the steam and oil, become in a short time brightly polished and very hard. The blocks and valves work in a case on the cylinder top, so that by removing the cover, the valves can be taken out, examined, and dropped back again. The water end consists of double-acting plungers working in internally packed stuffing boxes. This method of internal packing is adopted for small sizes and for working pressures up to 150 lbs. In the high-pressure type the internally packed water-plungers are replaced by four single-acting arms, attached to cross-heads, and connected together by outside tie-rods. It is therefore also quadruple-acting, but the stuffing-boxes are adjustable from the outside.

In the middle and larger sizes, in addition to the main valves, the motion of each piston drives cut-off valves which act on the back of the main valves as in the well-known Meyer gear. It has been found that this method enables the pumps to be run at a high speed without shock and at a constant length of stroke. The latest development is the "Oddesse" compound pump, one of which was shown at work. In this all the quiet running at high speed is noticeable, as with the non-compound pump, but the higher rate of expansion obtained effects a greater economy in steam consumption than is possible with the simple type.

Three-throw and direct-acting feed pumps also figured on the stand of *Lee, Howl & Co., Ltd.*, Tipton, and a novel pump for domestic, farm and horticultural purposes, formed the sole exhibit of the *Lamp Pump Syndicate, Ltd.* Driven by a paraffin stove, this pump has only two working parts, and is automatic in all respects. It is made of the best gun-metal, has no internal packings, a vertical direct action, and works by steam at atmospheric pressure, which is condensed and returned to the boiler.

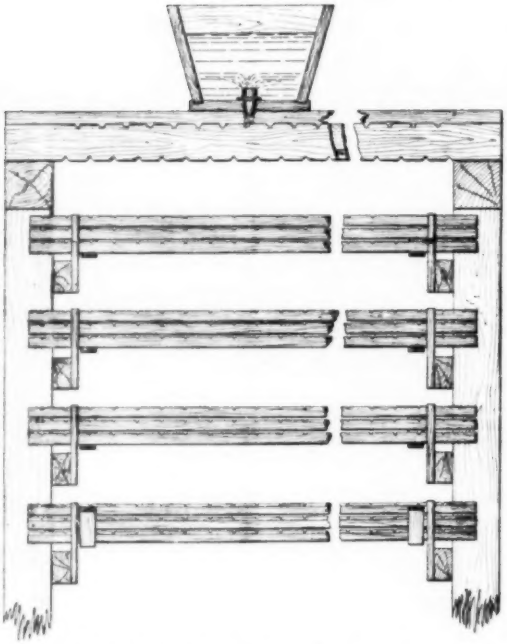
*Samuelson & Co., Ltd.*, Bunbury, had on view one of their well-known Roots' "Acme" rotary pumps, with a volume of discharge of 175 gallons of water, at 250 revs. per minute for a 50 ft. head.




"WILKINSON" LIVE-STEAM FEED HEATER: BEANLAND, PERKINS & CO.

## STEAM SPECIALTIES, VALVES, AND ACCESSORIES.

Feed-heating was represented at the stands of *Beanland, Perkin & Co.*, Leeds, the *Hudson Economiser Co.*, London, E.C., *E. Green & Son, Ltd.*, Wakefield, and *Lee, Howl & Co.* The first-named firm staged the recently introduced "Wilkinson" live steam feed-heater. This apparatus consists of a de-aërating chamber fixed at the highest position within the boiler into which the feed water is delivered, and a number of dishes and plates, fixed alternately, over which the feed water gravitates to a receiving chamber below. These are built round a vertical hydraulic tube passing through the shell of the boiler. This tube is open at its upper and closed at its lower end. A little mercury is poured down the tube to facilitate the transmission of heat to a thermometer which is inserted therein. This thermometer gives the temperature of the feed water at the point where it flows into the water space of the boiler. A tank and dip tube are fixed



CROSS-SECTION BROWN'S COOLING TOWER. HUDSON ECONOMISER CO.

below the receiving chamber and serve to convey the feed water at steam temperature to the bottom of the boiler, near the blow-off valve. A small pipe connecting the de-aerating chamber to an air valve outside the boiler, completes the equipment. It is stated that the heater is easily and cheaply fixed, and cleaned in a few minutes.

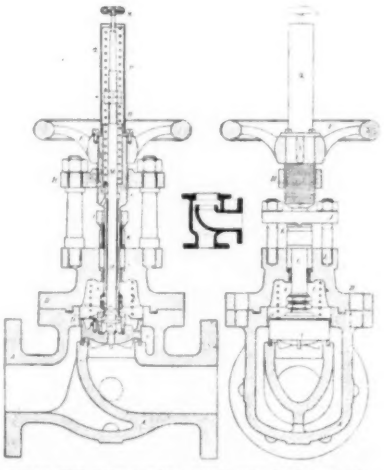
The "Hudson" economiser has already been dealt with* so that further description is unnecessary, but mention may be made of a working model of Brown's patent cooling tower, which was shown on this stand. It is of the chimney type, but, of course, may be adapted for the open or fan types. Its details will be apparent from the accompanying elevational illustration, the feature consisting in the arrangement of the hurdles composed of triangular members, giving a surface flow downwards over the lower face and so exposing a large area of water to the upward draught of cool air. The water dropping from the lower edge of the triangle is caught by the flat surface of the member beneath and an even distribution is secured by means of lateral gutters cut in the top surface. The apparatus is stated to be highly efficient, in one installation the temperature of the water being reduced from 120° to 72° F.

*Messrs. Green & Son* showed models of their well-known fuel economisers with the scraper gear in operation, a high-speed engine for driving economiser gearing, mechanical stokers and conveyors; sample castings of economiser tubes and photographs of economiser installations.

*Lee, Howl & Co.* exhibited several steam raising novelties, including the "Tipton" forced draught furnace for burning refuse fuels. The "Howl and Tranter" detartariser feed-heater constituted another interesting item on this stand.

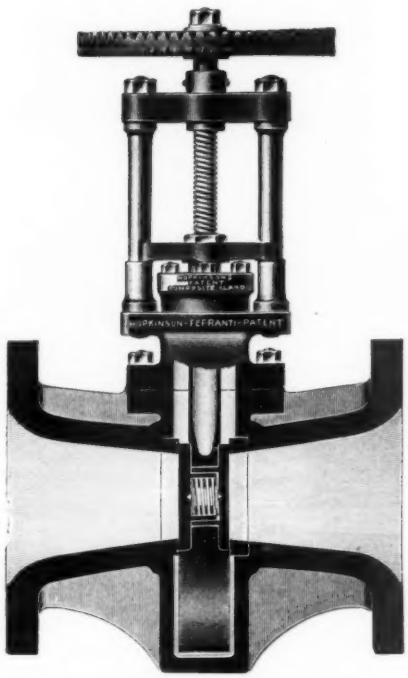
*The Mork Patent Pulley Block Co.* had a number of valves on view, amongst which was noticed a burst pipe stop valve with balanced pressure, which is illustrated.

The view shows the valve in the closed position. The internal valve *C* is a loose fit in the bore of the top flange, the metal disc *D* being a good fit and acts as a check valve. The hand wheel *F* is fixed to the hollow spindle *G*, in which the spindle proper, *M*, is arranged. This spindle has a spring *O*, working against the nuts shown the spring tending to lift the spindle *M* up. Another spring *P* is arranged above nuts *o*, by which the pressure of the spring *O* can be regulated. By turning the hand wheel *F*, the hollow spindle *G* is lifted up, and steam passes into the



BURST PIPE STOP-VALVE. MORK PULLEY BLOCK CO.

* ENGINEERING REVIEW, Vol. XV., No. 5.




"HOPKINSON-FERRANTI" STEAM STOP VALVE.
J. HOPKINSON & CO.

valve cover, as the internal valve *C* is not a tight fit in the bore of the top flange. There will, therefore, always be a quantity of steam above *D* with a tendency to hold down the metal disc *D*, which is increased by the action of the spring *E*. The steam pressure will also work on the collar *m2* and lift the internal spindle *M*. Steam can now pass through *N* and through the bore of *C*, and enter into the steam piping. There is now a balance of steam pressure above and below *C*, and the internal valve *C* may therefore, as soon as *m1* touches *M*, be lifted up easily. The valve is then in an open condition. Should any breakage occur a reduction in steam pressure will immediately take place, and naturally also below the internal valve *C*. The steam in the cover *B* will be of a higher pressure than that below *C*, and the valve will be automatically and immediately closed. By a turn of the hand wheel, the valve is again brought into the position shown in the drawing. There is, further, an arrangement marked *R*, by means of which the valve may be immediately closed in case of danger, without having to use the hand wheel. *Q* is a casing above the hand wheel, which can be secured by a leaden seal after the nuts have been adjusted to the required pressure.

*J. Hopkinson & Co., Ltd.*, Huddersfield.—The principal specialties manufactured by this firm were well represented at their stand, and consisted of the "Hopkinson-Ferranti" steam stop valve, silent automatic exhaust valve, automatic feed water regulator, and a new flue tube for Lancashire boilers. Other exhibits consisted of boiler mountings and steam and water valves for all purposes.

In the "Hopkinson-Ferranti" type valve the working parts of the valve are formed in the throat of a "converging-diverging" nozzle, the construction of which gives a smooth passage for the fluid when the valve is full open. The effect of this arrangement is to convert a portion of pressure energy of the steam as it travels into the converging nozzle into kinetic energy, the steam increasing in velocity and dropping in temperature and pressure. At the high velocity thus acquired it passes through the controlling part or valve proper. It now enters a diverging nozzle at high velocity, and in its passage converts its kinetic energy into increased pressure and temperature, until at leaving the nozzle it has returned to the same conditions of pressure, temperature, and velocity with which it entered the converging cone at the inlet side of the valve. It is claimed that by this construction the operative working parts are half the ordinary diameter, and will pass an amount of steam equal to the full carrying

SPRING TYPE PUMP PRESSURE REGULATOR.
CROSBY STEAM GAGE AND VALVE CO.

capacity of the pipe without appreciable drop in pressure.

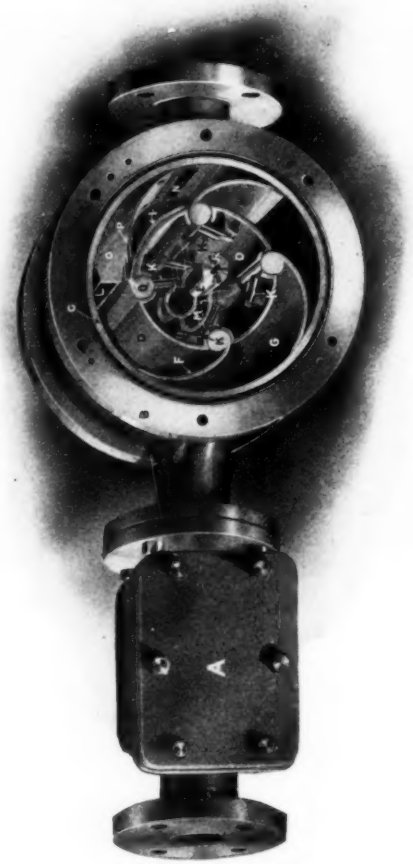
Many types of valves were on view at the stand of *W. H. Bailey & Co.*, amongst which may be noted the "Foster" reducing valve, and the "Key-ring" renewable valve seat, which is fitted in stop valves for high pressure superheated steam. It allows for differences of expansion between the seat and the body, and can be easily removed and replaced. The principle of the "Key-ring" is the adoption of a flexible metallic connection between the seat and the body, similar in construction to the well-known Ramsbottom piston ring.

Passing reference may also be made to the well-made patterns of steam gauges, water gauges and other fittings, displayed by the old-established firm of *Thos. Noakes & Sons*, London, E.C., comprising, amongst other types, special valves for superheated steam, a form of valve with renewable seat of a special alloy, and an improved lever safety valve, designed so as to be easily and quickly dismounted.

*Dobbie, McInnes, Ltd.*, Glasgow, had on view a variety of indicating apparatus, including indicators of their external pressure spring type, suitable for steam, gas or oil engines; indicators specially suitable for winding engines, the diagram being continuous and automatic, giving the variations due to change of load at every part of the stroke; continuous double diagram indicators for recording automatically and simultaneously diagrams from both ends of the cylinder, and giving time and revolution diagrams; "Mathot" continuous explosion and pressure recorders, designed specially for gas engines.

*Hunt & Mitton*, Birmingham, had a fine display of pressure, vacuum, hydraulic, oil, and pneumatic gauges, engine and boiler mountings, and steam boiler fittings. Attention should also be drawn to a power planishing hammer for flattening thin sheets. The blow of the hammer, which makes 250 strokes per minute, is cushioned by an air cylinder.

A profusion of steam fittings, together with indicators and gauge testing apparatus, appeared on the *Crosby Steam Gage and Valve Co.'s* stand. Amongst the indicators were some with an electrical attachment enabling cards to be taken from several cylinders simultaneously. Many different patterns of gauges were shown, of which the "Crosby" improved type may be mentioned. This is mounted on a slate slab and is fitted with double Bourdon tubes. Recent tests made at the National Physical Laboratory showed this type to be practically free from vibration, the pointer swerving out to something under the 1 lb. mark. Also shown were a number of "Mason" pressure control appliances for automatically regulating air, water or steam pumps, where it is necessary to maintain a constant pressure. Full particulars of this appliance will appear in a future issue. There was also a special form of pop safety valve without guides or wings, the edge of the valve being the frustrum of a sphere so that sticking is prevented.



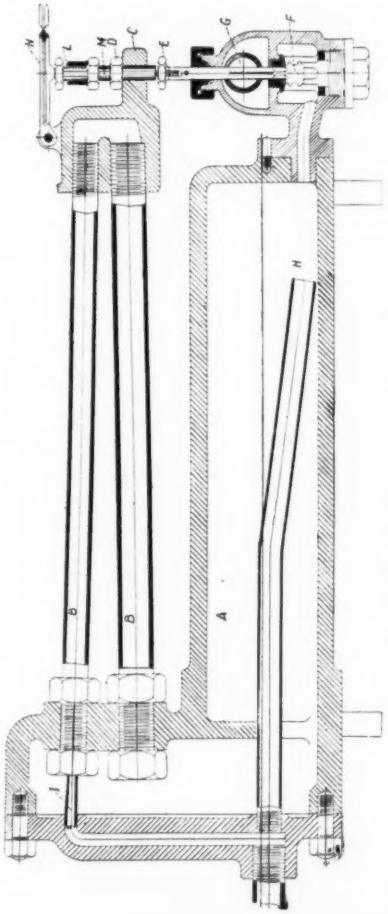
FEED WATER METER. SANDERS, REHDERS & CO.

*Sanders, Rehders & Co., Ltd.*, London, E.C. A boiler feed-water meter for measuring feed-water at highest temperatures proved to be

the novelty among the "Sarco" specialties. A sectional view of the apparatus is given in the half-tone on page 344. The meter will be seen to consist of the strainer box *A*, containing a cylindrical copper sieve, and the meter proper. The cast iron casing *B* is provided with a lining of phosphor bronze *C*, and the two covers to the casing are also lined with the same material. The moving mechanism is constructed of an alloy of nickel steel and a metal which is not affected by sudden and wide fluctuations in temperature. It consists of the drum *D* (mounted on the spindle *E*), and the wings *F*, *G*, *H*, *I*. The latter have attached to them, both at the top and bottom, studs *K*. The water flows in at *L*, and falling on wing *F*, causes the drum to rotate. This brings the studs *K* on this wing in contact with cam *M* (a similar cam is also attached to the top lid), and on moving on further, the latter forces the outside rim of the wing tightly against the casing, making a water-tight joint, as shown in the position of wing *G*. Simultaneously, wing *H* has moved round towards the water outlet *N*, and after having passed this, is gradually closed and pressed against the drum by the guide-block *O*. In the course of this movement, all the water between that wing and the drum is forced out at *N*. Before it can be released, the wing has to pass the two blades which are held open by the pressure of the water, and make a perfect joint between the inlet and outlet sides of the meter. These blades act at the same time as brushes, cleaning the wings of any scale that may have collected on them. As soon as the wing is released, the same action recurs. The meter is designed to make about 30 revolutions per minute. The motion of the mechanism is transmitted to the index, which is arranged on the upper lid by means of a small spindle, the flat end of which engages in the small slot *R* at the top end of the main axle. The automatic $CO_2$ recorder and the indicating steam meter will be already familiar to readers of the ENGINEERING REVIEW.

Simmance & Abady's $CO_2$ combustion recorders also figured amongst the exhibits of *Alex. Wright & Co., Ltd.*, London, S.W. This instrument records the percentage of $CO_2$ and the amount of air passing through on the same chart. *Arthur Ross, Hotchkiss & Co.*, London, S.E., as last year, gave demonstrations with working models, of the action of their automatic boiler circulator, and displayed a number of sample deposits removed from boilers by the action of the apparatus. The "Patros" steam trap was shown publicly for the first time, the details of which will be apparent from the accompanying sectional drawing. It is of the expansion type but discharges periodically, and the steam pressure is under the valve keeping it closed. The discharge water is cool, hence, it is stated, the wear of the valve is reduced to a minimum. A further claim is that it will work through a great pressure range without dribbling.

The reservoir *A* is for storing the collected water which accumulates and rises till the tubes *B* are cooled and contract, drawing down the head *C* till the intervening space between the set-screw *D* and the valve spindle *E* is traversed. On further contraction the valve and spindle are depressed, thus opening the valve *F* for water to be discharged at *G* until the water level has fallen below inlet pipe *H*, when steam is admitted through the bye-pass *I* to the top tube *B*. It continues circulating through lower tube, momentarily increasing the depression of head *C*, till all the water is discharged, when both tubes by expanding raise the head, and the valve is closed by the steam pressure under it.




"PATROS" STEAM TRAP. ROSS, HOTCHKISS & CO.

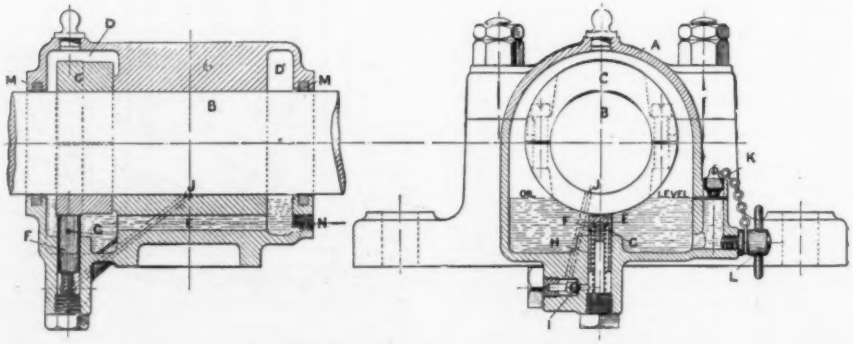
The spring *L* helps to bring valve promptly on to its seat. The pin *M* and handle *N* are for testing the trap at any time by hand.

*McPhail & Simpson, Ltd.*, Wakefield, showed a complete downtake superheater, tube plates, headers, superheater tubes and stop valves specially constructed for superheated steam; and *Geo. Kent*, London, W.C., had on view a number of hot water and boiler-feed meters of the "Venturi" type. This meter, which has no moving parts in contact with the fluid passing through the meter tube, consists of a tube forming part of the ordinary pipe line, from which it differs only in that it presents for a short distance a truncated reducing cone coupled by a throat-piece to an expanding cone.

The registering portion consists of two parts: first, of a mercurial U-tube, which, being connected with the up-stream and throat of the tube, brings in the element of the "Venturi" head or difference in pressure between these two points; and secondly, of the clockwork and gear controlled thereby, which supplies the element of time. The connection between the pressure and time is established by means of a float resting on the mercury in U-tube and rack and pinion gear. The "Venturi" head may be explained as follows:—Water flowing through a pipe of diminishing area loses the pressure which it exerts laterally as it gains in velocity. Conversely, water flowing through an expanding cone loses speed and regains head. This section may be concluded by the mention of the *Adjustable Cover and Boiler Block Co., Ltd.*, who staged a model of a Lancashire boiler, showing the adjustable system of setting with the firm's overlapping seating blocks and removable covers.

## PACKINGS, FRICTION REDUCING METALS AND APPLIANCES, &c.

Compared with the exhibits of a year ago few developments were observable in the almost overwhelming display of accessories comprised within this section. Very much interest, however, was displayed by visitors in these details, and for this reason, as well as to make our record of the exhibits fairly complete, the following simple notices are given. Commencing with anti-friction metals: the exhibits of *Willans & Robinson, Ltd.*, Rugby, mainly consisted of phosphor-bronze and white metal bearings cast by the "Etonia" process, a treatment which it is claimed gets over the troubles due to the segregation of the different constituents of the alloys, so that a practically complete equality in the structure of the mass of the bearing is obtained, and a consequent equal distribution of the load through every particle of the wearing surface. The *Hoyt Metal Co.*, London, E.C., showed samples of various qualities of white metals, as did also the *Atlas Metal & Alloys Co., Ltd.*, London, E.C. Some of the exhibits on this stand were specially interesting by reason of the fact that the bearings shown had been actually at work. Amongst these were a marine slide valve, showing a special application of white metal to this class of work; an armature bearing of an electric tram car, which had done a mileage of 84,000, and despite this distance was in first class condition; a pair of axle bearings of a heavy electric car, which were lined with the company's white metal re-run from the armature bearings when finished with. These bearings had a mileage of 36,400, and still appeared in good order. The *Glacier Anti-Friction Metal Co., Ltd.*, London, E.C., restricted their display to ingots of the following varieties: "Glacier" anti-friction metal, Findlay's special motor metal, plastic metal and babbitt metal. Roller bearings were represented by the *Hyatt Roller Bearing Co.*, London, S.W., and the *Empire Roller Bearing Co.*, London, S.W. The former exhibit comprised bearings for all kinds of purposes from very small bushings up to large bearings for standard shafting 5 in. in diameter. Bushings for various other kinds of work, high speed and low speed, under heavy




THE "TILSTON" FORCED LUBRICATION SYSTEM.

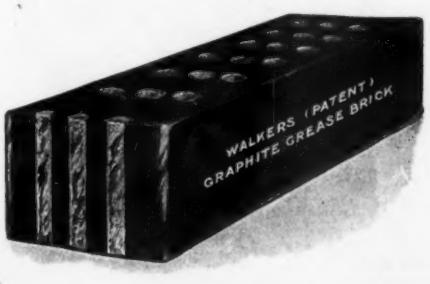
load were shown in great variety of sizes. The distinctive feature of this roller bearing is the roller, which is made from a strip of steel wound into a spiral-shaped spring of uniform diameter. The advantage claimed for this construction lies in its flexibility, enabling it to present at all times a bearing along its entire length resulting in a uniform distribution of load on the roller itself as well as the surfaces on which it operates. All tendency to distortion is said to be eliminated, as the roller tends to adjust itself to the irregularities present. From its construction the roller acts as an oil reservoir, while the spiral and rollers together perform the function of an oil carrier, thereby assuring ample lubrication.

We noticed one of the company's standard ball and socket pillow blocks, one of an order which has recently been installed in the works of Arthur Lee & Son, Ltd., Sheffield. This bearing is for a 7 in. solid shaft, and was shown alongside a small 1½ in. ordinary bearing, which provided a striking contrast to the massiveness and weight of the larger bearing.

There was also on exhibition at this stand bearings which had seen service. One in particular was a shafting bearing which had been in operation at the works of Strachan & Henshaw, of Bristol, for a period of about nine years. This bearing was in service next to the main drive pulley, and appears to be still in very good condition. Suspended above the stand was a huge model of the "Hyatt" roller, revolved by means of a small electric motor fitted inside the roller.

The *Empire Company's* exhibit comprised a working model on rails with axles fitted with roller bearings; fly-wheel models; railway and tramway axle boxes; swivel and rigid shafting bearings; trolley bearings and cages and rollers fitted with this specialty. This type of roller bearing is designed that the load bearing parts have a rolling movement upon solid cylindrical rollers, all of which are controlled in alignment with the axle or shaft by a special form of roller cage. This also separates each of the set of rollers to prevent the frictional contact of the adjacent roller surfaces which rotate in opposite directions.

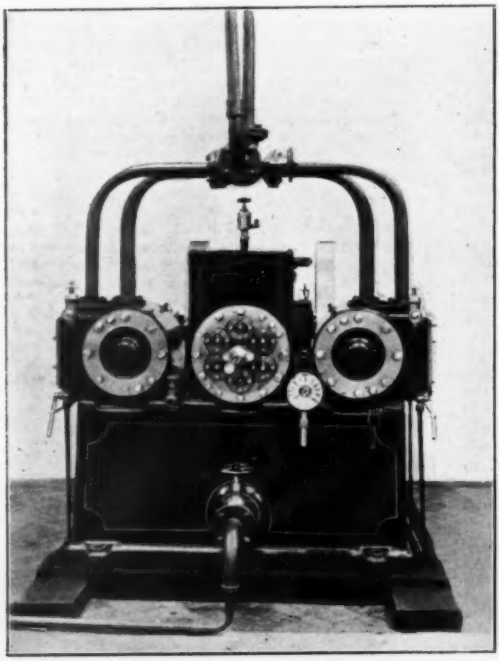
The "Tilston" automatic forced lubrication system was shown applied to bearings and bushes on the stand of the *Forced Lubrication Co., Ltd.*, Manchester. The principle of the system is clearly shown in the illustration on page 346. Sufficient oil is poured through oil feed *K* to last several months, and is forced through the frictional parts of the bearing and then returned to the oil chambers *D* and *D*1 to be forced through over and over again. The pump plunger or thimble *F* is reciprocated by the rotation of the eccentric *C*. When the plunger *F* is at the top of its stroke, the oil in the end chamber *D* escapes through the inlet holes *G* inside the pump. As the plunger descends the inlet holes *G* are cut off by the casting, and thus the oil is forced past the non-return valve *I* and through the outlet *J* to shaft to be lubricated. Each bearing has its own pump and is therefore self-contained, and existing bearings can be fitted. A system of positive lubrication specially adapted for high-speed engines and motor cars formed a novel feature at the stand of *Messrs. Thomas Noakes*. A sight-feed lubricator is employed, the oil being forced through valves at the bottom of chambers containing water, through which it automatically rises in any required number of globules per minute and is forced through the feed pipes direct to the cylinders and bearings. A few movements of the compressed air pump suffice to indicate a pressure of 15lbs. on the dial, which is all that is necessary until the oil tank requires refilling. The valves regulating the supply can be quickly adjusted and automatically lock themselves on a patent locking bar. The water magnifies the oil passing through it, and the supply can be regulated from any number of drops per minute, up to a continuous stream, should it be necessary to flood a bearing or cylinder. A small lever shuts off the oil when the car is not in use. A new sight-feed lubricator known as the "Wakefield" was shown at the *Albany Engineering Co.'s* stand. In this type the only pressure in the glass tube is that required to pass the drop of oil through the water contained therein. This is effected by one of two plungers actuated by a cam driven by a worm wheel. The oil on leaving the glass tube is passed under pressure by the second or lower plunger, to the parts to be lubricated. The *Joseph Dixon Crucible Co.*, London, S.W., had a working model of the latest in engine cylinder lubrication—an automatic graphite cylinder lubricator which delivers regularly the small requisite quantities of graphite in constant proportion to the oil or other liquid fed into the steam. The mixture of oil and graphite is continuously agitated from the moment the engine is started, and this agitation is kept up right to the point of entry into the steam pipe by means of a constantly revolving spiral conveyor in the connecting pipe in addition to the stirring propeller in the body of the




GRAPHITE GREASE BRICK FOR HEAVY BEARINGS.
JAS. WALKER & CO.

lubricator. A selection of force-lubrication specialties, manufactured by Manzel Bros., of Buffalo, U.S.A. was included in the exhibit of the *Combination Metallic Packing Co.*, Gateshead. In their design of cylinder oil pump, the feed of oils is measured off automatically, in small or large drops as required; the drops are then drawn through a sight-feed glass by suction, not gravitation, into the barrel of the pump. It is next injected into the steam pipe, chest, or steam cylinder, the whole operation proceeding, and repeating, at every stroke of the engine, so that, where the right oil is being handled, it is thoroughly atomized. The pump works fast or slow as the engine increases or diminishes speed; and as the pump is worked by the engine itself, it is inoperative when the engine comes to a stand. The force-feed lubricators for automobiles are an adaptation of the same principles of lubrication, a regular and positive feed being the result.

Coming on to packings, the firm last-mentioned showed a full range of their productions. The principle on which most of these operate is as follows: A series of springs at the top of the packing exert a pressure on the gun metal cases, which, resting on the bevel of white metal wearing segments, bring the latter up to the rod, sufficient to counteract the steam pressure. The vital part of the packing is necessarily the wearing segments, which are the only parts that are in contact with the rod. These are composed of a special alloy made only by this company. The *Beldam Packing and Rubber Co.*, Brentford, exhibited a full line of their specialties, including their well-known "Pilot" packing. For the benefit of those unfamiliar with this type, it should be explained that it is a combination of asbestos and white metal, the latter alone being in contact with the rod. Thus there is formed in the stuffing box a series of white metal rings, asbestos protected, and encircled by a special heat-resisting rubber backing stated to retain its elasticity under the highest temperatures. It is specially designed to stand the highest pressures, and is, we understand, in use on a number of steamers working at upwards of 220 lbs. It is made either in rings or lengths which are very pliable to enable them to be bent to fit any rod. The exhibit of *James Walker & Co.*, London, E. was very much of the nature and extent of the preceding. The collection included specimens of the new "Walkerite" jointing for steam, water, acid, ammonia, petroleum, and every description of joint, particularly for motor car engines; the new graphite grease bricks for heavy bearings; "Kerko" ammonia packing; and "Wallico" gauge glass rings; and "Lion" packings for all pressures of steam and water. Our attention was directed to a new feature which has been introduced in all these packings as a means of identification, viz., a "Thin Red Line" which runs right through them, and brass trade-mark labels. Also shown were "Wallico" valves for circulating, air and diaphragm pumps, and packings of several types for steam hammers.



AIR COMPRESSOR (BACK VIEW). HATHORN & CO.

At the stand of the *Dexine Patent Packing and Rubber Co., Ltd.*, Stratford, a special feature was made of their patent metallic boiler feed pump buckets designed to replace gun-metal pistons and vulcanite rings. Their ability to withstand a temperature of 350° F., and a working pressure of 500 lb. per sq. in., is one of the claims made, another being their successful working in scored barrels with a consequent increased utility in the pump. "Dexine" composition, of which they are made, is a combination of vulcanized india-rubber and other ingredients, prepared by a special process and in the form of steam jointing, manhole rings, &c., and withstands superheated steam to 700° F., and resists the action of heated oils.

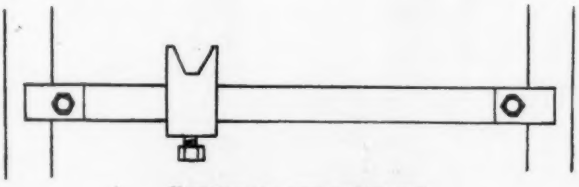
Finally, there was the *United States Metallic Packing Co.*, Bradford, with a fine collection of their well-known packings for marine, stationary and locomotive engines. In its essentials this type of packing consists of a

number of blocks held in strong rings, having pockets or horns, holding springs. The packing blocks are put together in sections, four blocks to a section. Each section is composed of two working blocks, babbitt lined, and two guide blocks. The joints between the blocks in one section are at right angles to those in the other section, thus breaking joint. The blocks are regulated by springs, which merely keep the parts in place when the steam is shut off, as, when steam is applied, the steam pressure regulates and sets the packing. A ball joint on one side, and follower with springs on the other, give the packing free play, and keep it steam tight without regard to the vibration of the rod. Minimising friction, it does not wear the rod but gives it a high polish. With efficient lubrication the blocks wear very slowly, a packing being shown which had been in use for 16½ years, also the rod, which does not show any appreciable decrease in diameter. The whole packing is enclosed in a strong case and bolted to the cylinder head with the usual stud bolts.

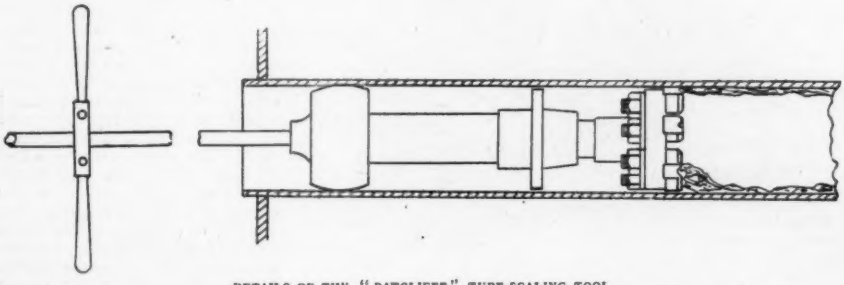
WOOD BORING AND CHIPPING UNDER WATER.

## AIR COMPRESSORS, BLOWERS, PNEUMATIC TOOLS.

Air compressors of varying types, mostly all old friends and therefore not calling for detailed description, were exhibited by *Reavell & Co., Ltd.*, Ipswich, *W. H. Bailey & Co., Ltd.*, Manchester, *Thwaites Bros., Ltd.*, *Hathorn & Co.*, London, and the *Consolidated Pneumatic Tool Co., Ltd.*, Fraserburgh. In addition, there were numerous examples of blowers throughout the exhibition, those manufactured by *Samuelson & Co., Ltd.*, Banbury, and *Thwaites Bros.*, and *Alldays & Onions*, Birmingham, being conspicuous. Fans there were also in abundance. One of the most attractive stands in the whole exhibition was that of the *Consolidated Pneumatic Tool Co.*, who, in addition to the air-compressor above-mentioned, showed several classes of their machines, such as "Boyer and Keller" hammers, "Boyer," "Keller," "Little Giant," and "Whitelaw" drills, and emery grinders, under working conditions. An interesting application of these tools forms the subject of the accompanying illustration, showing the operation of wood-boring and chipping under water. This was demonstrated by a diver in a special tank, having observation windows through which the various operations could be

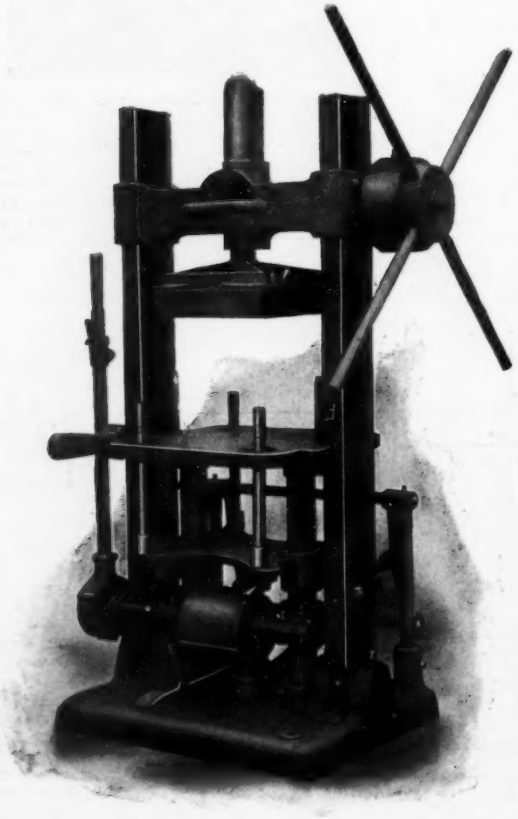


V-SUPPORT FOR TUBE SCALING TOOL.



DETAILS OF THE "RATCLIFFE" TUBE-SCALING TOOL.

witnessed. This was a joint exhibit on the part of the Consolidated Co. and Messrs. Siebe Gorman, the latter company being responsible for the diving apparatus and tank. Frequent demonstrations were also given with the "Ratcliffe" improved direct-acting tube-scaling tool, which is operated by the "Boyer" pneumatic hammer manufactured by the Consolidated Co. As will be seen from the accompanying detailed illustration, the tool consists of a series of small cutters fitted into a circular block, the spindle of which is reciprocated by the "Boyer" hammer. A rotating motion is at the same time imparted to the tool by the operator by means of the adjustable handle shown, which latter is screwed on to the guide-pipe piece at a suitable distance from the guide block for the tool to be manipulated without undue strain. The cutting edges of the tool are so arranged as to strike direct on to the scale to be removed, thus making the tool positive in action, as it cannot pass through the tube without removing all obstruction. The sides of the tubes cannot, it is stated, be damaged by the cutting edges as they do not come in contact. The machine is under the perfect control of one operator, the air-supply being regulated by a throttle-valve fitted at the end of the guide-pipe-piece and within easy reach. It is essential that each tube should be cleared of all scale for a depth of about 6 in. to allow the tube-scaler to enter freely; this can be easily done with either a pneumatic or ordinary hand-hammer and chisel. The guide-bar and V block, as illustrated, is then bolted to the front frame, so that the lengthening-piece — which acts as a guide as well as carrying the air-supply to the hammer —may be supported in the V. The tool is then operated until the entire length of guide-pipe or air-shaft has entered the tube, when another lengthening-piece is coupled up, and so on until the whole of the tube has been cleared. The best result is said to be obtained with an air-pressure of from 80 to 100 lbs. per sq. in., the heavier pressure being necessary only when dealing with exceptionally hard, thick scale. The exhaust air from the hammer is directed forward so as to clear all but the very large pieces of broken scale from the cutters. We were informed that in actual work, one of these cutters removed scale ¾ in. thick from a 4 in. tube at the rate of 3 in. per min.



PATENT MOULDING MACHINE. BRITANNIA FOUNDRY CO.

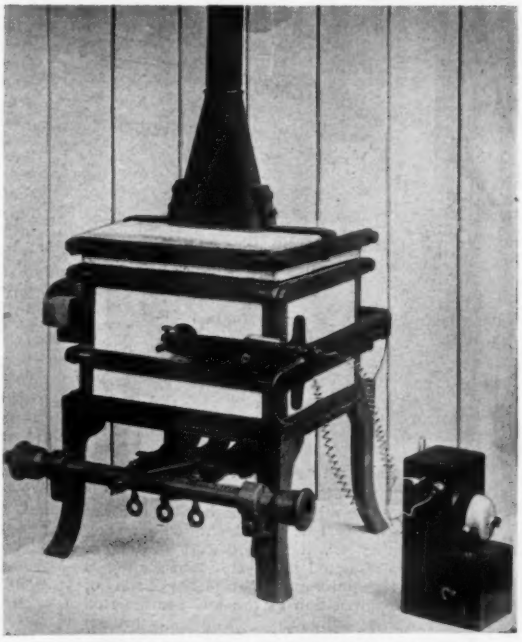
The complete assortment of electric drills and magnetic drill posts shown on this stand are dealt with elsewhere.

### FURNACES, CASTINGS, &c.

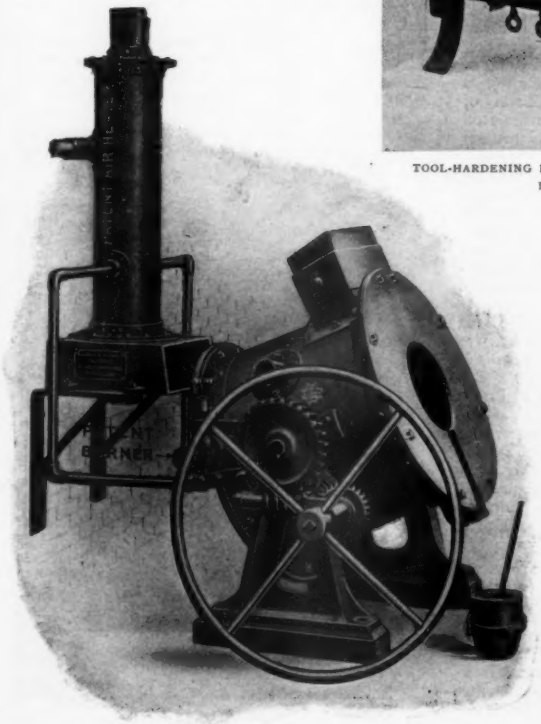
The only moulding machine in the exhibition was to be seen at the stand of the *Britannia Foundry Co.*, Coventry. A recent invention, it is known as the "Coventry" machine, and is fitted with a mechanical gear in the head that enables a man, without undue exertion, to ram any mould as hard as is required. The power ram and lift, although hand applied, is not of the lever and toggle joint hand variety, which is suitable for only very simple and shallow jobs. The ram works with a squeezing motion, and the operator can easily gauge the amount of pressure. The lift is steady, true and parallel, and not only lifts the mould off the pattern, but the moulding box off the table

pins. The pattern plates are made in a simple manner from a non-shrinking mixture of white metal.

Two furnaces were in operation on the stand of *Alldays & Onions, Ltd.*, Birmingham, one a stationary type of gas furnace for annealing, hardening, and case hardening, of the same pattern as shown last year, and a crucible tilting gas furnace. This type has been specially designed for melting brass, copper, aluminium, and iron for malleable castings. It possesses some advantage over the stationary type where the crucible has to be lifted out with tongs, the greatest of which is the much longer life of the crucible owing to the fact that it is not removed from the furnace when pouring but remains in the hot furnace, and is thus protected from coming into direct contact with the cold air and thus the sudden contraction, which is so destructive to the crucible, is avoided. The air is heated to a high degree before it enters the furnace. The air rom the blower is conducted to a receiver which surrounds the chimney pipe, and after entering it near the top leaves it near the bottom, by which time it has practically attained the temperature of the gases in the chimney. The furnace is lined with fire brick, and the burners project the flames against the concave lining, causing the flames to take a spiral course round the crucible, thus avoiding cutting action against the sides. The proper proportion of air and gas for complete combustion is controlled by each burner, and is adjustable both for the air and gas at the nozzle, hence when the volume of air or gas is adjusted no alteration of pressure takes place.

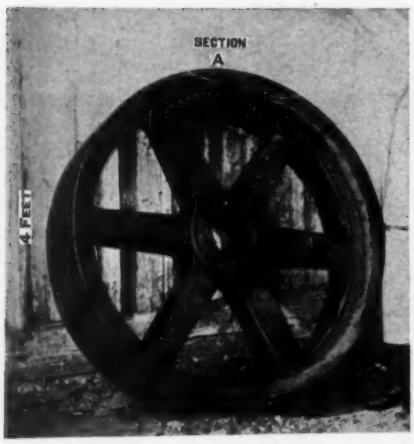


TOOL-HARDENING FURNACE WITH HARDENING POINT INDICATOR. BRITISH GAS FURNACE & TOOL CO.



CRUCIBLE TILTING GAS FURNACE. ALLDAYS & ONIONS.

Shop hardening specialties, consisting of a number of tool-hardening furnaces, case hardening furnaces, boxes, and composition, formed the collection of the *British Gas Furnace and Tool Co.*, Birmingham. A decided novelty was a unique arrangement for hardening in one of these furnaces which was shown in operation. It forms a simple and accurate indicator,




CASTING BRAZED WITH "CASTOLIN." WASSERMANN & CO.

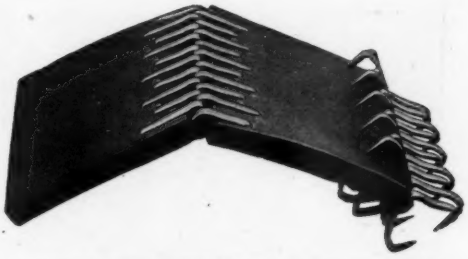
as the ringing of a bell denotes that the point of recalescence has been reached. Under such circumstances it will be seen that burning of the tool is rendered impossible and scaling is reduced to a minimum. Two pieces of steel of the same composition as the tool are inserted in the furnace walls through which they project and make contact with the tool. The arrangement forms part of a circuit which includes a battery, bell and magnet. When the tool reaches the hardening point contact with the projecting pieces is broken, thus breaking circuit, which releases the magnet armature and causes the bell to sound. A Fèry pyrometer was staged for reading the temperatures of this furnace.

A small annealing furnace, suitable for annealing copper wire and small articles, was shown in operation at the stall of the *Bates & Peard Annealing Furnace Co.*, Huyton. The object of this furnace is to attain a bright annealing on all non-ferrous metals, which come from the furnace free from scale or discolouration, and thus avoid the pickling and washing. Means are provided for the automatic loading and unloading of the metal into and from the annealing chamber, which is never opened to the atmosphere, and after once reaching the necessary heat only requires to be maintained at that temperature. The heat which would be dissipated by having to remove the cover of the furnace for the purpose of extracting the pot is thus available for annealing.

A process for brazing cast-iron by means of a flux called "Castolin" and a special brass spelter termed "Castolot" was demonstrated at intervals at the stand of *Wassermann & Co.*, Lausanne, represented in Great Britain by *Mr. T. W. Sheffield*, of London, E.C. "Castolin" is a product which has been worked out in the laboratories of Messrs. Wassermann. It is not difficult to use and needs no special plant. It is first rubbed into the pores of the broken surfaces which have been previously cleaned with a wire brush. The pieces are then joined together accurately with clamps and placed in a clear charcoal fire, assisted by a gas blow-pipe for large castings. When they have become hand-warm more of the "Castolin" is rubbed into the fracture. The line of fracture is then covered with plenty of borax and "Castolot" spelter, and the casting is replaced in the fire and brought up to a red heat until the "Castolot" spelter runs freely with a bluish flame. The brazed casting after polishing is as good as new in appearance, and, as has been shown by a series of severe tests carried out by D. Kirkcaldy & Son, the fracture will resist breakage as well as the rest of the piece. Three cast-iron bars, broken at mid-length and rejointed by the "Castolin" process, averaging ·56 sq. in. area, submitted to tensile tests broke with a mean ultimate stress of 6·9 tons per sq. in., breaking at the joint. In bending tests bars of 1 in. section, similarly broken and jointed, broke partly at the joint and partly through the solid at an ultimate stress of 1,523 lbs. Other tests show even improved results, and demonstrated the reliability of this method of brazing. This, combined with its simplicity, should render it of importance to machinery users generally. A number of cast-iron articles brazed by the process were on view, our illustration showing a pulley thus treated (section *A*).

UNIVERSAL VICE WITH BALL JOINT. MESSRS. WADKIN & CO.

Another patented process for repairing castings in cast iron, aluminium, steel and wrought iron was exhibited by The *Magnoid Co., Ltd.*, London, E.C. Demonstrations of the "Warden-Simplex" system of oxy-acetylene welding were given at frequent intervals by *A. Warden & Co.*, London, E.C. Castings of various kinds figured on the stands of *Aerators, Ltd.*, who showed alloy die finished castings; *Thos. Butlin & Co., Ltd.*, Wellingborough, cupola castings, particularly pipes; and at that of *Norman & Young, Ltd.*, who displayed die finished castings in aluminium and various hard alloys.

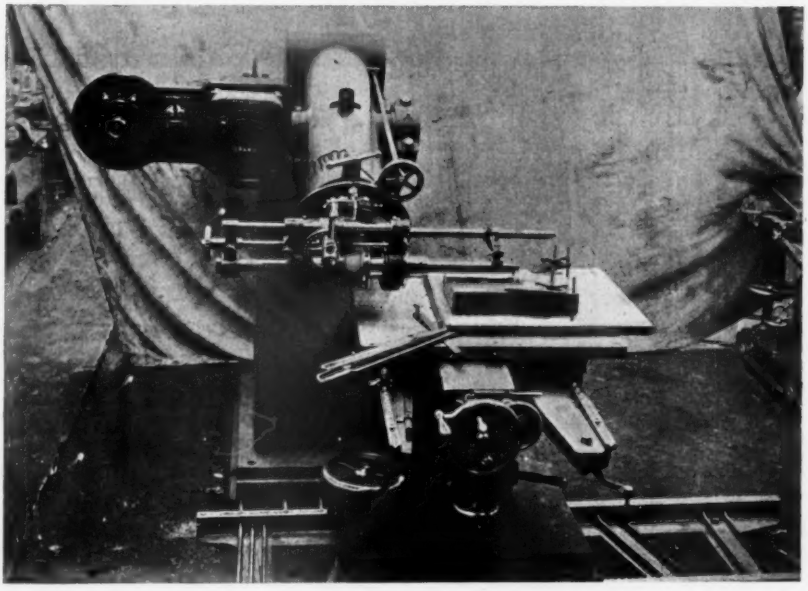


FLEXIBLE STEEL LACING FOR BELTS. J. B. STONE & CO.

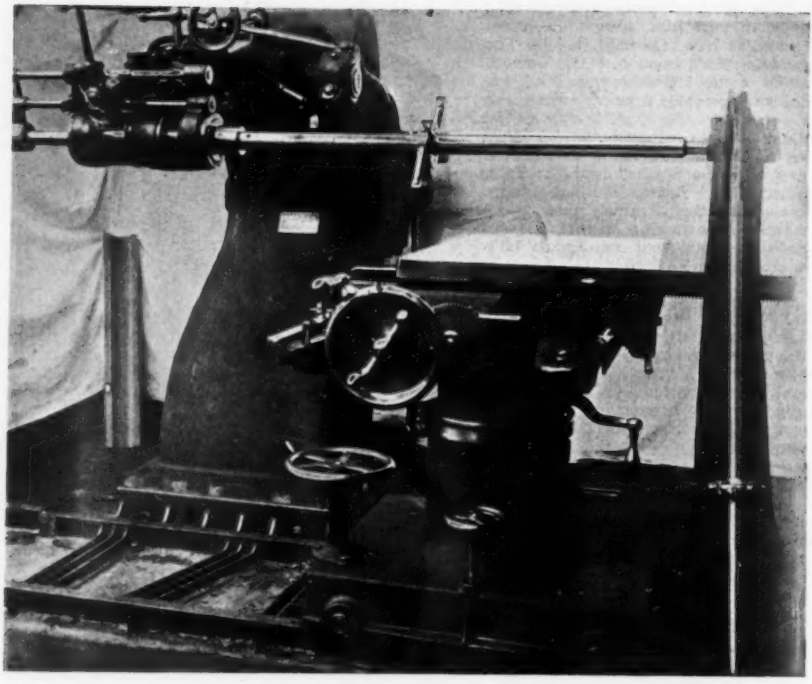
## WOOD-WORKING MACHINERY.

There was a fairly representative display of machinery suitable for use in wood-working and pattern making, *Messrs. Wadkin & Co.'s* exhibit compelling much attention. Their mechanical woodworker has been much improved since first it was described in the ENGINEERING REVIEW, and has now special features of construction which enable almost every conceivable operation in pattern making to be carried out easily, rapidly and economically. The machine has practically universal motions to the cutter head and the table, and both are provided with quick and fine positive feed motions. It applies equally well to the fine delicate work of some shops as to the large and heavy work of others. On corebox and pattern work, gear patterns, &c., its use should effect considerable saving over older methods. We give two views of the machine as it appears when operating on core boxes and when using a bracket and boring bar for large work.

Space considerations prevent us to do more than mention a new wood trimmer or skiver and a new corner lock jointing or square dovetailing machine shown by Messrs Wadkin. A new patent universal vice, with ball joint at base was on view. As will be seen, it forms an



THE "WADKIN" MECHANICAL WOODWORKER OPERATING ON CORE BOXES.



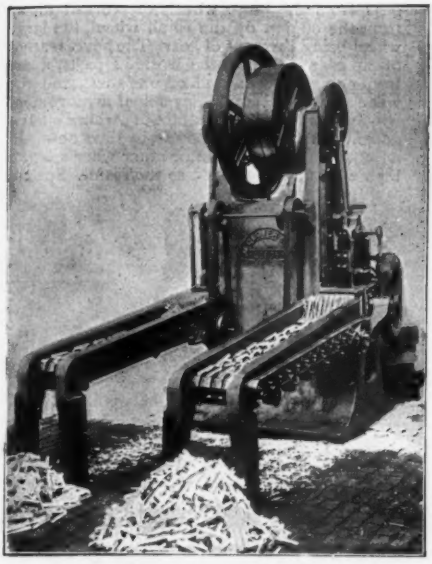
THE "WADKIN" MECHANICAL WOODWORKER AS ARRANGED FOR BORING LARGE WORK.

deal quick-change vice, and is applicable to an unlimited range of work. It is well made, handy, durable, and moreover cheap.

*Beanland, Perkins & Co.*, Leeds, had on view an improved chain mortiser, in which the work is performed by an endless chain whose links are formed as cutters. This chain is driven at a high speed by means of a sprocket wheel, which supports its upper part, the lower part passing round a friction pulley mounted on the end of a guide bar. *Messrs. Sagar & Co., Ltd.*, Halifax, showed a hand and roller feed surface planing, moulding, and thickening machine, pattern makers' lathes and dimension sawing machines; *J. B. Stone & Co.*, chain mortising, hollow-chisel mortising and dovetailing machines and other machinery suitable for pattern makers. Belt fasteners figured on the latter stand, amongst which was a novelty of the flexible type. This lacing, which is stated to be suitable for any kind of belting, is made quite easily with only a hammer.

The square ends of belting are first pushed into the lacing until tight against the mid-rib. After which the end prongs of each section are pressed into the belt, using either fingers or light hammer tap, so as to hold the lace on the belt straight. The lacing is then placed over a hard surface and the hooks or prongs seated by striking with hammer.

*M. Glover & Co.*, Leeds, made a representative display of their patent machinery for sawing, splitting, screening, arranging and bundling firewood. We illustrate this firm's latest splitting machine, into which, by means of a self-feeding apparatus, the wood is conveyed to the knives and thereby the sticks are cut at one stroke with remarkable precision and regularity. The feed can be adjusted to cut sticks of a size varying from about ¼ in. to 1 in. thick or thicker if ordered, and the machine can also be adapted for splitting lengths of wood for use as fuel. Special precautions have successfully been taken in this machine to prevent wedging and friction. A screening arrangement is attached, consisting of troughs with active rollers, canted so as to throw forward the sticks and allowing the dirt and waste to fall between. The sticks can be automatically delivered to the firm's bundling machines if required. These are made in two types—the foot-power and, for larger users, a



FIREWOOD SPLITTING MACHINE. M. GLOVER & CO.

power-driven machine, which works in combination with a mechanical chip arranger. By this ingeniously constructed machine the sticks are sifted, dropped into narrow spouts, made to assume a uniform position lengthwise, and are shot forward by travelling belts into narrow boxes, and thence into a measuring box, until finally they are shaped into bundles and wired.

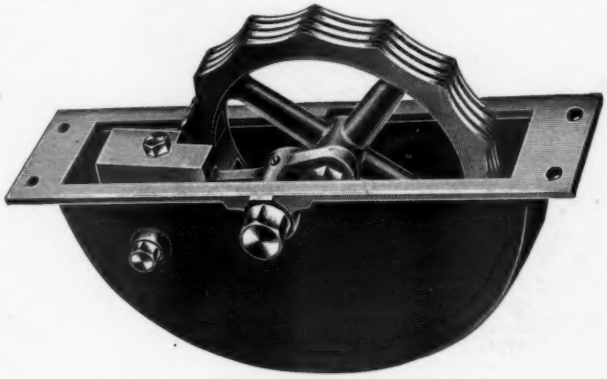
The firm also exhibited an improved saw sharpening machine and several of their well-known "Ideal" saw guards. We also noticed further specimens of their new safety circular cutter block which we recently described in our columns, and an improved labour saving device for compressing and bundling box and case boards.

## PRIME MOVERS AND BOILERS.

This department of engineering was very poorly represented, in fact, was hardly up to the standard of the 1906 exhibition. The sole turbine was that of the "De Laval" type mentioned before in connection with Messrs. Greenwood & Batley's exhibit. Steam engines of small power were shown by W. H. Allen & Co., Ltd., Bedford; Clarke, Chapman & Co, Ltd., Gateshead; E. & S. Hindley & Sons, Bourton; Reavell & Co., Ltd., Ipswich; Samuelson & Co., Banbury; and Thwaites Bros., Ltd., Bradford. Gas engine and suction producer plant was represented by Crossley Bros., Ltd., Openshaw; R. Hornsby & Sons, Ltd., Grantham; E. & S. Hindley & Sons and The National Gas Engine Co., Ltd., Ashton-under-Lyne. Oil engines combined with dynamos, water pump and vacuum exhauster were shown by The Heatly-Gresham Co., Ltd., London, E.C. Messrs. Clarke Chapman showed a steam drum of "Woodeson" patent water tube boiler; Cochran & Co. (Annan), Ltd., confined their exhibit to hand-painted diagrams of their vertical multitubular boiler. A steam generator in actual operation was that of T. Noakes & Sons, Ltd. This was of the small water tube type, with three sets of tube coils and a paraffin burner and supplied steam to the small rotary engine exhibited by the Pittler syndicate.

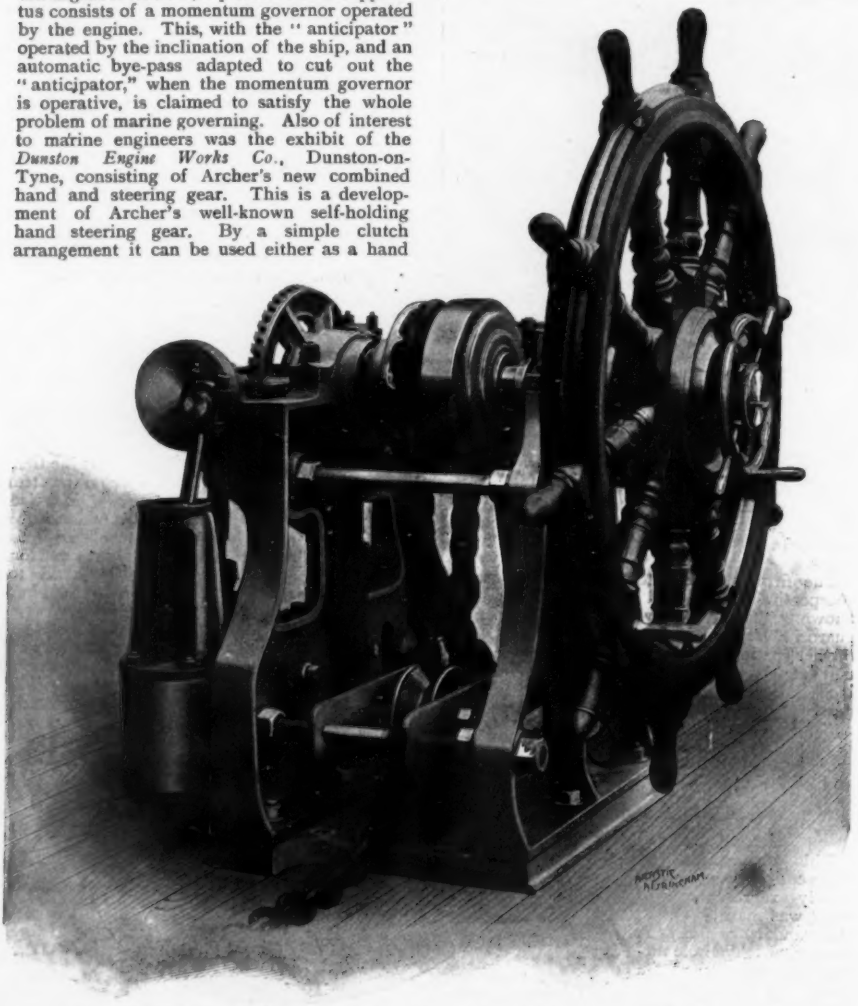
## MISCELLANEOUS EXHIBITS.

*Andrews' Governor Patents, Ltd.*, London, S.W. This exhibit formed one of the novelties of the exhibition. It consisted of a working model of an automatic marine governor which purports to anticipate the submergence of a ship's propeller, and thus to automatically cut off steam sufficiently ahead of the actual reduction of resistance as to prevent racing, owing to the amount of steam which would be left in the cylinders, valve chests and receivers at the time of the reduction, unless such were anticipated. The device by which this is effected is called an "anticipator," and consists of a tube adapted to pivot about a transverse axis relative to the ship, and containing a certain quantity of mercury. It is arranged to normally keep a control valve on its seat, but



NEW SECTIONAL TUB AXLE GREASER. FALCON IRONWORKS.

when by the motion of the ship through any more than a minimum angle of inclination the mercury is sent by its own momentum from one end of tube to the other, the tube is tilted by gravity and the valve, held normally by it, is then released, and fluid under pressure is allowed to pass to the controller to operate the throttle valve. To meet conditions arising from the varying depth of the propellers when they are submerged, which would vary the engine resistance, a portion of the apparatus consists of a momentum governor operated by the engine. This, with the "anticipator" operated by the inclination of the ship, and an automatic bye-pass adapted to cut out the "anticipator," when the momentum governor is operative, is claimed to satisfy the whole problem of marine governing. Also of interest to marine engineers was the exhibit of the *Dunston Engine Works Co.*, Dunston-on-Tyne, consisting of Archer's new combined hand and steering gear. This is a development of Archer's well-known self-holding hand steering gear. By a simple clutch arrangement it can be used either as a hand gear from the large wheel, or worked direct from the engine by the small wheel, the large wheel being then out of gear. The novel feature of the gear is that all the working parts, apart from engine, are carried on one shaft, and the wheel gearing used is a cycloidal arrangement which is the principal feature of Archer's hand gears. The requisite power is thus obtained without the use of worm or other wheels, and a high efficiency is claimed as the result. Special



ARCHER'S COMBINED STEAM AND HAND STEERING GEAR. DUNSTON ENGINE WORKS.

WIRE ROPE HAULAGE CLIP. FALCON IRONWORKS.

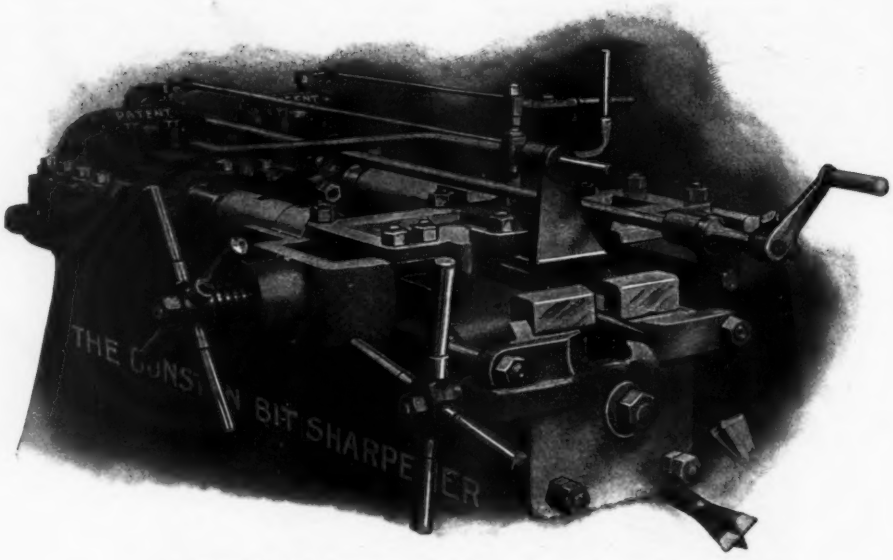
care appears to have been taken to make all working parts, both of gear and engine, accessible, and the gear has evidently been designed with the object of being simple and efficient. The gear does not continue to make a number of revolutions after the hand wheel stops, but stops at once.

Of interest to mining engineers was the stand of the *Falcon Ironworks, Ltd.*, Oldham, who showed a pair of self-contained semi-portable geared winding or hauling engines of their well-known "Falcon" type. These engines are specially designed for underground or surface work, and are made to withstand rough usage, and for that purpose are strong and simple in construction. Two novelties, however, figured on the stand, the first being an automatic sectional tub axle greaser. This embodies an entirely new method of applying oil or grease to tub axles. It is stated that only sufficient oil is applied to lubricate the axle, there being no surplus oil to drop off and no waste. The rim of the oiling wheel, as will be seen from the illustration, is made in sections, with spaces between each adjusted to suit the consistency of the oil used. As the tubs pass the oil is applied in a thin film at four or five points on the axle, and is spread by the bearing as the axle revolves. The surplus oil immediately drains away down the spaces between each section into the containing vessel.

The other mining novelty is the "Atherton", wire rope haulage clip. These clips are made to suit all sizes of ropes for under or over tub haulage systems, are self-gripping, and automatically locked on the rope. There are no adjusting screws, bolts, or nuts to work loose. These clips, which will pass freely over pulleys or round curves, are reliable even on the heaviest gradients since the load provides the gripping power; hence the greater the load the more secure the grip. The jaws are mechanically opened and closed by one handle. The clip can be instantly attached and released from the rope. The operating handle (which is only about 6 in. long) requires to be smartly brought to the on position, when the clip is securely attached and automatically locked on the rope. It can be easily attached to the rope with one hand, standing clear of the tub, and entirely does away with the dangerous practice of standing in front of the tub. A specially important feature is that it is equally efficient to pull, push or hold back the load.

Another mining feature was an "Eclipse" rock drill, shown working on the stand of *Hathorn & Co.*, London, E.C. The special features of this are (1) its portability, being suitable for gadding purposes and in all positions where space is limited, and (2) the automatic feed which operates only at the moment when the progress of penetration warrants the advance of the drill.

Adjacent to the above stand was that of the *Tuckingmill Foundry Co., Ltd.*, Camborne, who showed a number of mining implements, including specimens of rock drill bits, forged by the "Dunstan" bit forging and sharpening machine. This is a new apparatus which, in its action, imitates as closely as possible, by




BIT FORGING AND SHARPENING MACHINE. TUCKINGMILL FOUNDRY CO.

mechanical means, the hammering a hand-made bit receives from a smith. In operating the machine, the heated steel is held in a conical die beyond which it cannot expand, while a power hammer fitted with a suitable head rapidly forges the end of the bit to the desired shape.

To form ⊣⊢ or X shaped bits from a round or octagonal bar, the bits are first heated and inserted in the vice. The split conical dies are closed, and air or steam turned on to the first horizontal hammer, which is fitted with a jumping-up die. Here, with a few rapid blows, the steel is upset and partially split to form the wings. The bit is next inserted in the die box to the second horizontal hammer, where the splitting is completed, and the wings formed with a suitable die. The bit is finished with a few more blows of the first hammer, on which the jumping-up die has been replaced by a finishing die. The principal use for the machine on a mine is in sharpening the dulled bits rather than in forging new bits. In this case the jumping-up process is dispensed with.

Chisel-shaped bits, or bits of any other practical shape, can be forged and sharpened in a similar manner to that described, and the shanks of machine drill bits, whether parallel or tapered, can be swaged with rapidity and accuracy. The capacity of the machine is 240 shanks per hour.

Another mining appliance was staged at the stall of the *Warsop Petrol Rock Drill Syndicate, Ltd.*, Chorley, and consisted of a rock drill, using petrol as a motive power, having its own operative power within itself, being, therefore, self-contained. This apparatus has already been described in our columns.

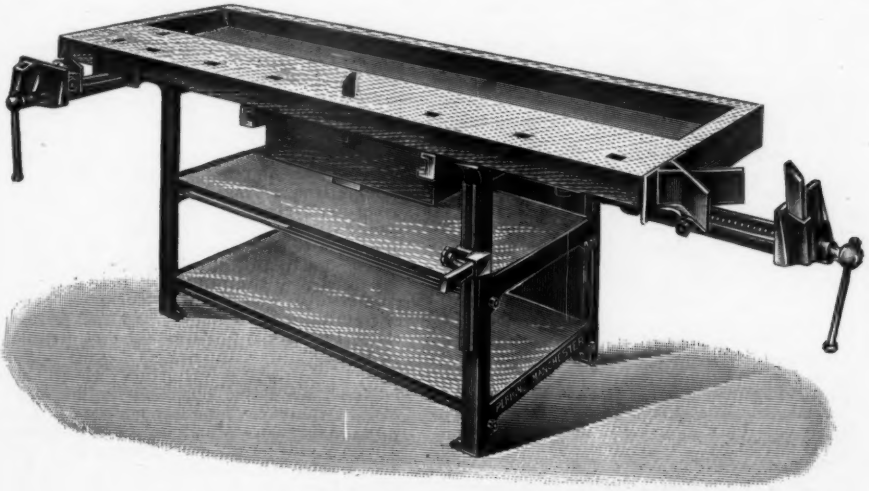
A passing mention must also be made of the *Wilfley Mining Machinery Co.'s* exhibit, which was restricted to machinery for metalliferous mines, and included ore crushers, picking belt, and band conveyor, and the well-known "Wilfley" concentrator.

*Bullivant & Co., Ltd.*, London, E.C., had a large and varied exhibit of steel wire ropes and all appliances in connection therewith. The various stages of the manufacture of wire rope from the iron ore to the finished article were shown. In the first stage, iron ore previous to smelting; in the second, iron ore in briquette form for shipment; in the third, pig iron smelted from ore; in the fourth, a fractured ingot partially planed to show solidity; in the fifth, a steel ingot after being compressed; and in the final stage the steel rods from which are drawn the fine wires for making up into rope. In the centre of the stand there were four large pyramids of special extra flexible and extra flexible steel wire rope, both galvanized and ungalvanized. There were also purchase and non-purchase reels, a crab winch to lift 2½ tons direct from the barrel; a portable nipper for gripping a 2½ in. circumference rope; an automatic nipper, tested to 10 tons, for gripping a 3 in. circumference rope; and 18 in. sheave blocks, 1,

2, 3 and 4 fold, the latter tested to 68 tons. One particularly interesting case contained a sample of a rope 5¼ in. circumference, having a guaranteed breaking strain of 100 tons, and five samples cut from the rope after it had been in use for nearly three years, and had run 80,171 miles. The mean breaking strain of the five samples cut from this rope was, when tested, 76·02 tons. Reference has already been made to the working model, demonstrating the firm's system of aerial ropeway for raising, lowering and transporting heavy loads. Also shown was a new device for cutting wire ropes or chain specially suitable for collieries, rigging lofts and shipyards, and an adaptation of the same machine for cutting ropes under water. These machines require only one man to actuate them, and in the short space of a minute steel wire ropes up to 9 in. circumference can be cut.

*Newton & Nicholson*, South Shields, displayed a wide range of Taylor's patent corrugated metallic jointing, suitable for all classes of jointing, either heat, wet, petroleum, or high pressure boiler stays and boiler mountings. *W. H. Perkins*, Manchester, had two sizes of a handy bench for pattern makers and wood workers, the mechanical arrangements of which rendered almost any class of work capable of being adjusted and fixed in a very rapid and secure manner. The illustration shows a standard type bench 7 ft. long by 2 ft. 6 in. wide, fitted with two vices of an improved type, 9 in. by 4½ in. jaws to open 12 in. The front vice is shown with a swivel jaw which has a screw adjustment for any taper or wedge-shaped work. The tail-end vice is shown with circular grip for cylindrical and semi-circular work. These attachments are instantly fixed or removed, and will fit any "Perkins" vice of this type. The back standard is shown fitted with a vertical and horizontal slide for supporting heavy work in conjunction with the front vice, and for long edge planing. The bench is slotted with holes in both the length and width of the top and is fitted with a tool rack, drawer and two adjustable planing stops on the front end.

The *Patent File and Tool Co., Ltd.*, London, E.C., showed their new milling file. As this has already been noticed in our columns it will suffice to mention that the file has semi-circular teeth cut on both sides, and a supporting back which enables the mechanic to get a good purchase over his work. It is stated to be self-clearing, and equally efficacious when used upon steel, iron, bronze, aluminium or marble; further, that it leaves a smooth surface. Another claim is that it can be re-sharpened four times, at about half the cost of re-cutting an ordinary file. The *Walsall Hardware Manufacturing Co.* arranged their stand to show to advantage various grades of steel conduit and fittings, including their grip continuity system, which is stated to make a perfectly metallic joint, to dispense with all screwed and loose parts and to considerably reduce the cost of electric light wiring. The process known as Sherardising, by which steel, wrought and cast iron are protected from rust, has been fully described in THE ENGINEERING REVIEW by the inventor, Mr. Sherard Cowper-Coles. Numerous articles so treated were on show at the stall of *E. A. Brandon & Co.*, London, E.C., who are developing the process commercially. *Glenfield & Kennedy, Ltd.*, Kilmarnock, had on view Lea's recording instruments for the



PATTERN-MAKER'S BENCH. W. H. PERKINS.

SOLE AGENTS FOR GREAT BRITAIN
IRELAND & THE COLONIES
The VINCIT CO LTD
87 QUEEN VICTORIA ST E.C.
The VIENNA CARBORUNDUM WORKS

THE VINCIT CO.'S STAND

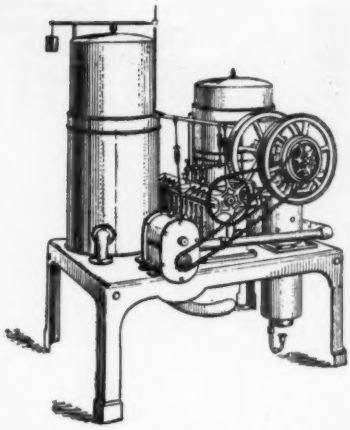
measurement of water flowing over weirs and notches; a waste water meter, fitted with clock and diagram arrangement, to give record of the quantity of water passed; an electric, water level indicator and recorder to indicate and record in an office any distance away the level of water in a reservoir or tank, and a recorder to give a record of the pressure in steam or water mains.

It is hardly necessary for us to deal with the "Fastnut" washer, a device for obviating the use of check nuts, drilling bolts and fitting castle nuts and split pins, since we have already devoted space to it on more than one previous occasion. Moreover, it is by this time so widely known as to have become generally accepted as an indispensable item, and is ordered and put into stock with the same necessity as are the nuts, studs or screws destined to be their close companions in any construction subjected to vibratory motion. Many examples of the "Fastnut" application were shown on the stand, not the least interesting being that on bolts holding bearings with $\frac{1}{8}$ in. play and shafting running at 1,000 revolutions per minute. The nuts were removable with finger and thumb, yet failed to slacken even under this intense vibration.

*W. Summerscales & Sons, Ltd.*, Keighley, had the field to themselves in laundry engineering with their "Challenge Renown" washing, boiling, rinsing and blueing machine, an ironing and finishing machine, and a shirt, collar and cuff ironing and finishing machine. Abrasive materials were represented by the Vincit Co., Ltd., London, E.C., the Carborundum Co. and Markt & Co. "Electrite" forms the specialty of the first-named firm, which, like carborundum, is a product of the electric furnace. The new product is not quite so hard as carborundum, but it is superior in hardness to both corundum and emery. In its amorphous state its grain is less rough and is capable of better resisting pressure and shock. It is said to possess a further great advantage, viz., that of adhering more tenaciously to polishing bobs, belts, &c., than the carborundum grain. It produces a very free cutting wheel and can be used, and is recommended, for practically all purposes where carborundum has hitherto been employed. It is claimed that it does not heat the metal ground like carborundum, but there are still classes of work for which it is advisable to use the latter abrasive, which is also manufactured by the company by the well-known vitrified process.

The exhibits consisted of wheels, cups, files, wet stones in both materials, and included two large wheels, one 31 in. by 4 in. by 2$\frac{3}{4}$ in "Electrite" wheel, and one 39$\frac{1}{2}$ in. by 6$\frac{1}{4}$ in. by 4 in. carborundum wheel, which the exhibitors believe to be the largest carborundum wheel of the vitrified type yet manufactured.

The Carborundum Co.'s exhibit was naturally very similar in character, and included an assortment of wheels, from the largest diameter to the smallest dental wheels, crude carborundum crystals as taken from the furnace, sharpening and oil stones, grains and powders, paper, cloth and discs for surface grinding and rubbing blocks used by ironfounders for rubbing iron castings. The third-mentioned company, Messrs. Markt, showed a range of similar specialties in corundum. The vitrified process is generally employed in the production of these wheels, that is, after being mixed and dried they are "burnt" in kilns at a temperature of 3,000° F., producing a wheel of great porosity, durability and uniform texture. For certain kinds of wet tool grinding or for heavy work, the silicate process is employed, and where very thin wheels are required, the elastic process. By the latter method wheels can be safely made as thin as $\frac{1}{16}$ in., as they have a high degree of elasticity. They are used for smooth surfacing hard steel and can be run in caustic soda. They are particularly serviceable for cutting off brass tubing and strips, thin steel wire, also for



PETROLISED-AIR APPARATUS.
NON-EXPLOSIVE GAS CO.

slotting, gumming thin saws and grinding very fine tools and instruments.

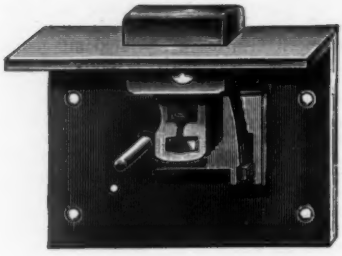
Demonstrations of the manufacture of air-gas and of its application for illuminating purposes by means of an apparatus invented by F. J. Cox, M.I.Mech.E., caused much attention to be paid to the stand of the Non-Explosive Gas Co., Ltd. The method of manufacture consists of mixing air with a small proportion of vapourised petrol to enable it to be ignited in a burner of suitable construction. The apparatus employed consists of a hot-air engine driving a small rotary pump which forces air through a carburettor into a balance governor which regulates the supply and pressure according to demand. The petrol supply is from a separate tank, the feed being regulated by the governing apparatus, it being set on first starting up to give a mixture of 2 per cent. petrol and 98 per cent. atmospheric air. This is a non-explosive mixture, as it will not readily ignite except when passed through the special burner. In starting up the motor is turned by hand until the gas-holder has become charged with petrolised air. The petrolised air is then lighted at the burner which supplies heat to the motor. The latter speedily commences to work, and the manufacture of the gas then proceeds automatically so long as it is being consumed at the burners.

An inverted type of incandescent burner is used which is stated to have an illuminating power of 90 candles, and that by the use of one gallon of petrol an illuminating effect equivalent to 12,000 to 13,000 candle hours is produced, or as much as is obtained by means of 1,000 feet of ordinary coal gas. The apparatus would appear to be useful for country houses and in districts where a coal gas supply is not available.

The *International Time Recording Co.*, London, E.C., showed a "Bundy" time recorder, which keeps an accurate check on the time put in by employés. Every employé makes his own record with a numbered key, which by means of clever mechanism leaves a printed impression on a paper tape. Its capacity is unlimited, and during the 24 hours any number of records can be made by any number of employés. An increase of staff simply means an increase of keys. Improper registration is impossible, there is no congestion, and on an average 60 persons can register per minute. The tramway time recorder is another exceedingly clever and practical contrivance, well adapted for tramway working. A printed record is obtained of the exact time at which a car passes a certain point, thus rendering comparisons with scheduled times easy and definite. Its accuracy is such that a time-keeper can be dispensed with, and as accuracy is indispensable for all tramway systems, its advantages are clearly obvious. The "Rochester" card recorder was also shown. This is an apparatus for checking the time of employés. The timekeeping of each person for a week or more may be registered upon a card by means of this machine, thus avoiding the necessity of daily transferring such time to a wages sheet. It is also the exponent of a useful system of labour-costing.

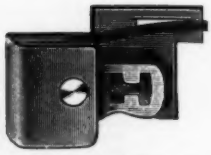
The time registers by *Howard Bros.* was also a good one, and included the well-known "Dey"

OVERHEAD RUNWAY. MORK PULLEY CO.



DRAWER LOCK.

CROSS-SECTION OF LOCK.



FRONT VIEW OF BOLT AND LEVERS.

SIDE VIEW OF BOLT AND LEVERS.

machine for recording the time of the arrival and departure of employés by means of a weekly combined time and wages sheet. These sheets give the number of the employés in numerical order, with the whole of their ingoings and outgoings for the week on the line opposite their numbers, with extension columns for writing in the total number of hours worked, rate, amount to pay, &c., and can be arranged to suit any requirements and for any number of hands up to 200 on one sheet. By means of an additional attachment, the time spent on different jobs can be recorded on cards for the purpose of cost-keeping.

A small and simple machine, known as the "Dey" cost-keeper, was on view. This is for the purpose of prime cost-keeping by cards. This machine is entirely automatic, requiring attention only once a week.

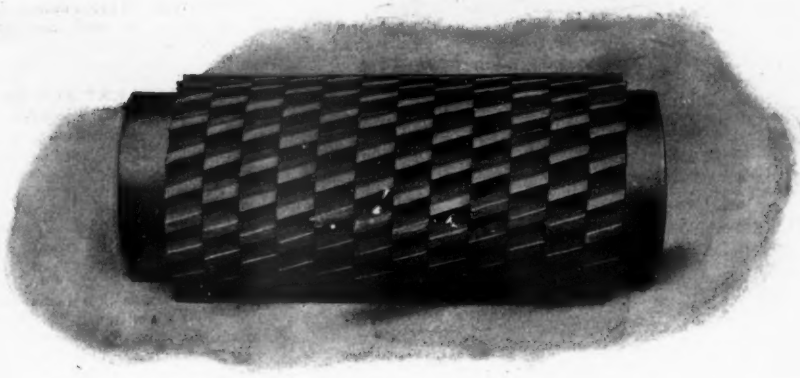
Mention may be made of a new autograph time recorder, on which the firm have been experimenting for some time past, and which they have now perfected, and hope to be turning out for sale at a very early date.

Somewhat similar in character was the exhibit of *Llewellin's Machine Co.*, Bristol, with a "Realm" recorder for checking any hour or minute, day and night, during seven days. This recorder requires no attention from any official, the machine being entirely automatic from the time the diagram sheet is put on until it is taken off. There was also a "Realm" card recorder, each person's time for 14 days being recorded on a card. Cards can be used for checking each day's attendance, as well as the time occupied on job work. Each man prints his own record. Time checking machines, in which metal checks are used, and an autographic machine in which the time can be ascertained by means of the position of the signature on the diagram sheet, were also on view.

A new system of overhead runways was on view at the stand of the *Mork Pulley Co.*, a section of which is illustrated. It will be seen that a special bent steel plate track of gutter-like shape is attached to the joist by means of hangers, and that the trolley runs in the groove. This trolley is fitted with 4, 8, 12, or 24 rollers in accordance with the load that has to be carried; the steel-plate track, however, is the same for any capacity. The trolley has ball bearings. The switches, curves and turntables are all made to one standard, and are carefully adjusted to work freely.

As before mentioned, one of the novelties to be seen was the "Margewood" lock, the construction of which reveals much ingenuity and marks a distinct advance in lock design. We doubt very much whether nine people out of ten, until they inspected this stand, understood the construction of the ordinary lever lock, and consequently did not appreciate its inherent defects. One is that the bolt itself is solid only at the head, the portion inside the lock being cut away to provide space for the levers. These work separately from the bolt upon a lever stump or pin which has only one support, viz., in the bolt itself. Thus, when this pin is forced, bent, broken or works loose, the whole lock is valueless until repaired. In the "Margewood" lock this lever stump or pin has a double support, one at each end, with a consequent increased rigidity. Moreover, the levers which work over it form a combination with the bolt itself being pivoted therein, as is well shown in the accompanying side view. It will thus be seen that the strength of the lock is considerably increased without involving any complex construction.

*T. Demant*, Newcastle-on-Tyne. The difficulty of obtaining adequate translations of catalogues, specifications, contracts, price lists



NEW DESIGN OF MILLING CUTTER. SAMUEL OSBORN & CO.

involving technicalities incidental to engineering, is well known. We ourselves have had more than enough experience of the ordinary type of self-styled technical translator whose blunders would be amusing if they were not serious. Bearing on this was an exhibit of a kind not often seen at exhibitions, namely, documents of the order above mentioned, translated from and into English, French, German, Spanish, Portuguese, Italian, Danish, Norwegian, Swedish, Dutch, Russian, and Modern Greek. Testing them by the French and German samples, they appeared to be free from any of the inaccuracies usually found, which is accounted for by the fact that Mr. T. Demant himself has, besides a wide knowledge of languages, the advantage of an engineering training.

### TOOL STEEL AND IRON.

High-speed tool steel, although in use throughout the exhibition, did not figure extensively as an exhibit. What there was, however, was of a high order. *Messrs. Samuel Osborn & Co., Ltd.*, Sheffield, exhibited specimens of their "Mushet" high-speed steel. Two of these tools were seen cutting a hard wagon tyre on the boring mill at Messrs. Butler's stand. A high-speed drilling machine by the same makers operated twist drills at the following speeds:—

| Size of Drill. | Material Drilled. | Revolutions per minute. | Rate of penetration per Minute. |
|---|---|---|---|
| ¾ in. | Mild Steel. | 500 | 8 in. |
| ¾ in. | Cast Iron. | 500 | 17½ in. |
| 2 in. | Steel 28 tons tensile. | 160 | 2½ in. |

These rates were even exceeded at the demonstrations given by Messrs. Butler, the drills appearing to be quite unaffected by the length of time they were at work or by the heavy duty imposed on them.

We noticed several very heavy cuts taken also with a "Mushet" tool on the 9 in. lathe at *Messrs. Alfred Herbert's* stand. The "Mushet" high-speed steel milling cutters were exhibited in various forms which show there is no difficulty in the manufacture and hardening, whatever the required shape may be. A specimen of a new design of a milling cutter was of special interest. Its outstanding features are that it is possible to renew a broken portion without recutting the whole of the tool. In work it operates with an oscillating motion so that there is a sawing as well as a direct cutting action. Messrs. Butler's planing and slotting machines were also at work cutting cast-iron and steel with "Mushet" steel. A number of interesting specimens, illustrating the beautiful silky fracture of "Mushet" steel, were shown, as well as specimens of "Titanic" brand of water hardening cast steel, fractures of which were shown in different tempers and also in various stages of manufacture. Samples of Messrs. Osborn's crucible cast-steel files, illustrating the variety of sizes and cuts, also the different processes of manufacture were also to be seen. Not the least interesting item was a piece of ferro-maganese with which the late Robert F. Mushet experimented in the "Bessemer" process, and given by E. F. Mushet to the late Samuel Osborn in 1858.

The other exhibit of high-speed tool steel was that of *Sanderson Brothers and Newbould, Ltd.*, Sheffield. The "Saben" brand was shown in operation on the heavy 12 in. lathe by Messrs. John Stirk & Sons, which is illustrated earlier in this report. A high-speed drilling machine by Tangyes, Ltd., Birmingham, was also on this stand shown operating "Saben" drills. A 30 in. "Sabén" high-speed saw, mounted on a cold sawing machine by Clifton & Waddell, Johnstone, was seen

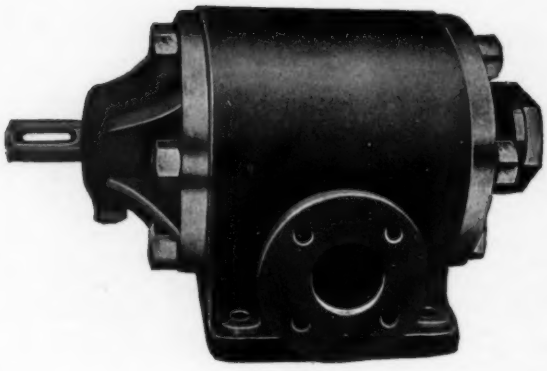


FIG. 1.

taking cuts at 80 ft. per minute and cutting joists 6 in. by 5 in in 4 minutes. In show cases were fractures of steel, rounds, squares and hexagon bars, with files and rasps, while various types of "Saben" high-speed tools for turning were shown loose. There was a fine collection of high-speed drills, reamers, cutters, punches, and razors, also a "Bower's" inserted teeth cutter, with "Saben" high-speed blades, and an inserted teeth cold saw. A testing block was also noticed, showing strength of different steels, for motor and cycle work, in its natural state and also case hardened.

Iron exhibits were confined to pigs. *H. B. Whitehouse & Son, Ltd.*, Bilston, showed fractured samples of best foundry pigs, especially suitable for high-class castings, where strength, combined with softness for machining, and fluidity are desired, with fineness of surface and low shrinkage. "Priorfield" iron has had a run amongst users of best foundry iron for close upon a century under the brands of "Wallbrook" and "Priorfield." The Priorfield furnaces were built in 1839 and the brand altered from "Wallbrook" to "Priorfield" henceforth. The Wallbrook furnaces were carried on by Messrs. Whitehouse during the earlier part of last century, and their iron at one time sold for as much as £9 per ton, before the hot blast was introduced. A licence to use hot blast was granted to Mr. H. B. Whitehouse in the year 1835. This is probably the only one now in existence in South Staffordshire, and was shown in the pig iron sample case on this stand.

*Messrs. Butlin & Co., Ltd.*, Wellingborough, displayed samples and analyses of the well-known "Butlin" brand of pig iron. This is made from a scientific mixture of carefully selected brown hematites of the district, which, with the application of chemical analyses, result in great uniformity of product, as well as high quality.

## THE "PITTLER" ROTARY ENGINE AND PUMP.

We have reserved the consideration of this invention until last by reason of the difficulty experienced in classifying it, as the claim is made that it will work with equal efficiency either as a steam engine, pump, hydraulic meter, motor, or air compressor. However, it will probably stand or fall on its merits as the first-mentioned class of machine, the bold statement being made in the circular issued by those responsible for its exploitation, viz., the *Pittler Rotary Machine Syndicate*, that it is "a commercially perfect rotary engine." If, indeed, the inventor, Herr Von Pittler, of "Pittler" lathe fame, has succeeded in solving the problem of that engineering ideal, a valveless, reversible rotary engine, he has achieved a monumental result, and will deserve a niche in the temple of fame alongside that of James Watt. We must leave to our readers to judge from the following descriptions and illustrations whether or not these expectations seem likely to be realised, and whether the weak points of previous attempts in this field have been eliminated. Figs. 1 and 2 will best serve to illustrate the principle of the machine, its application as a hydraulic motor and air compressor being worked out in detail in Figs. 3 and 4. The machine consists of an outer casing bored for two ports, an inlet and outlet, which are used alternately for the purpose of reversing. Inside the casing is the principal member or drum, which is turned and ground to a sliding fit, and rotates on a shaft carried in long end bearings. Four grooves are milled into the drum exactly 90 degrees apart; into these grooves vanes somewhat longer than the drum are fitted so as to slide evenly and smoothly in two directions parallel to the shaft. This axial

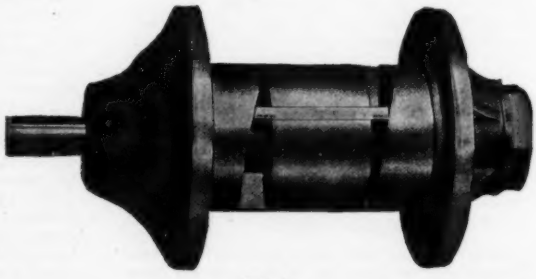


FIG. 2.

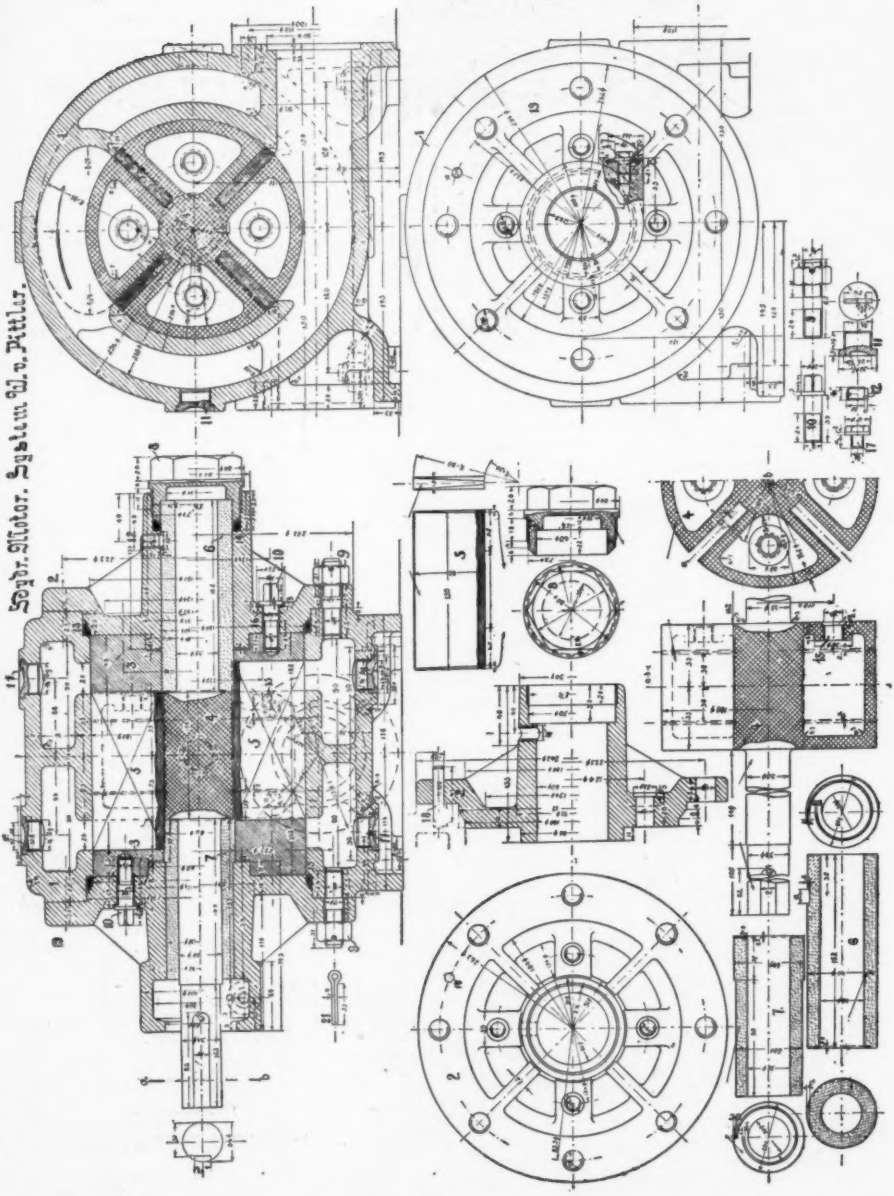



FIG. 3.

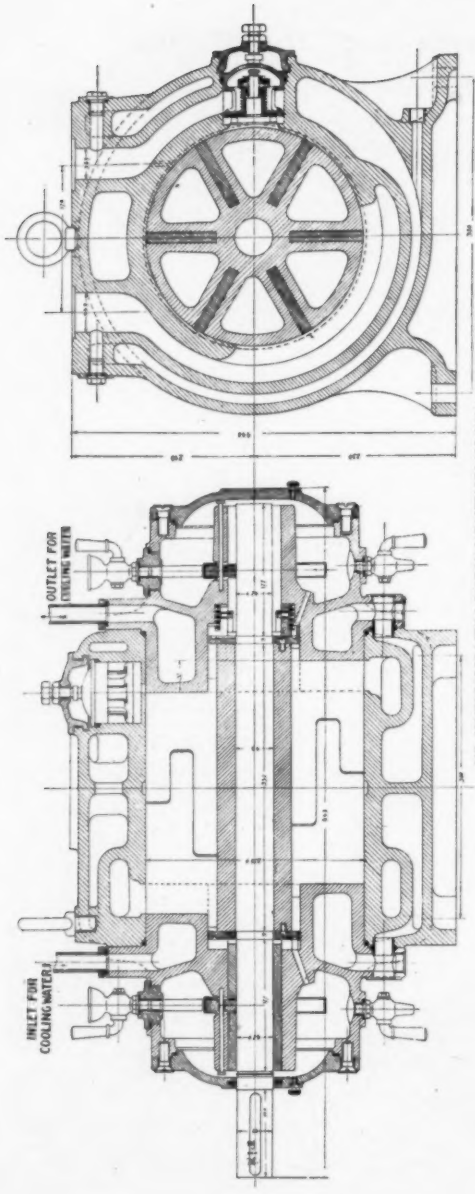



FIG. 4. AIR COMPRESSOR WITH A SUCTION CAPACITY OF 2420 CUBIC FT PER HOUR
*.* ALL MEASUREMENTS IN MILLIMETERS

movement is given to the vanes by the specially constructed end plates or cams, upon which they bear slightly during their revolution. The inside faces of the two cams are made in duplicate, and are composed of two flat and two curved portions. The end plates are so fixed that the flat portions of the one are exactly opposite to the flat portions of the other, the curved planes being also exactly opposite to each other. The vanes being made to a sliding fit between the cam plates, it follows that, as they rotate they will be reciprocated thereby from side to side, and will slide into opposite positions each portion of a revolution the vanes come between the curved portions. No sliding movement of the vanes takes place during the portion of the revolution that they are between the flat planes, which is the period during which work is being done upon them. The vanes being set at 90 degrees, and pressure being on two opposite vanes at the same time, prevents any dead point, and provides a constant turning movement in either direction. There is an entire absence of shock, inasmuch as the flow of fluid, steam or air is constant in the direction of rotation. The displacement and sliding movement of the vanes are exactly balanced, and during the period the vanes are sliding they are in equilibrium. To secure this immobility of the vanes during the time that work is upon them has been one of the several difficulties encountered in the problem of the rotary engine. On the stand the engine was shown working as a pump, air compressor, steam engine, and applied to a motor chassis as arranged for hydro-propulsion. In the latter case its application involves no change speed gearing, speed regulation being obtained by varying the delivery of the pump to the two driving motors. Both the latter and the pump follow broadly the design shown in Fig. 3.

## THIRD PRIZE COMPETITION.

**Notice of awards made will appear in the next issue.**

# The Electrical Features of the Olympia Exhibition.

*By ANDREW STEWART, A.M.I.E.E.*

THE Engineering and Machinery Exhibition, while it had some shortcomings, bore ample evidence of the ubiquity of the electric motor. One was to be found on almost every stand where machinery was in motion, and if some performed their duty in an unostentatious way, this is due more to the perfection of the apparatus, and excellence of manufacture, than to any attention which they got. Some were located on the top of a stand, and were started up from a switch on the wall, or on the floor, and left to run all day long, week in and week out. Others were built into the machines they drive, and of course led a more eventful life.

The latter feature of the show cannot fail to impress the engineer whose memory takes him back over a number of exhibitions, great and small. Time was when the steam engine played an important part in all exhibitions, it was succeeded by the gas engine, and even yet, although it no longer persistently obtrudes itself in exhibitions, there is evidence that the gas engine will play an important part in industrial history, though probably in large units only.

Now, of course, electricity is the motive power which makes the wheels go round, and impresses the man in the street with the vast importance of mechanism in the production of the apparatus which ministers to his comfort and convenience. What the motive power of the next decade will be, time alone can show, and though electricity may have a long and successful innings, one would have small faith in the inventive power of posterity if they concluded that its innings would be indefinite.

At present it holds a position unchallenged by any rival, and it can be put to a greater variety of uses than any other agent, whether that agent be a prime or only a secondary source of power, or heat. Depending, as it does, on its older rivals, steam or gas, yet it has displaced these as a means of driving almost all kinds of apparatus. At Olympia you could see it driving everything from a set of plate rolls and a lathe to a hairbrush, it could be seen welding metals in a fraction of the time and at a tithe of the cost by any other means. The products of the electric furnace were seen in the form of carborundum and aluminium. It was seen driving the fans, lighting the buildings, and, in the annexe, it braved the perils of the mighty deep, rendering service to the diver in his efforts to salve an imaginary wreck. All these things, and more, electricity does, and does it well.

Until recently the electric motor, when applied to a machine, was stuck on apparently as an after-thought, and appeared more frequently as an excrescence than as an integral and well-thought-out part of the machine. The 30-in. vertical boring mill exhibited by Messrs. John Stirk & Sons, Halifax, showed what can be done where the inherent implicity and adaptability of the electric motor is realised. The motor is an integral part of the pillar which (*inter alia*) forms the magnet yoke. Only the end-plate carrying one bearing and screening the commutator can be seen, so that easy access is afforded to the vital parts of the motor, and it would be difficult to evolve a more satisfactory design. This motor drives on to the lower cone pulley by spur gearing, which cannot be seen as it is inside the pillar. The motor is 2½ horse-power, and is capable of giving this output at any speed from 800 to 1,600 revolutions per minute. By utilising the full speed range of the motor, the gear box, and the cone pulleys, any speed from 5 to 250 revolutions per minute may be obtained on the table.

Messrs. Stirk also exhibited on the stand of Messrs. Sanderson, Sons, & Newbould, where a standard 10 in. lathe, which, however, has been modified in order to adapt it for 12 in., was shown, driven by a 35 h.p. electric motor. Spindle speeds varying from 10 to 200 revolutions per minute are available, and though the electric drive is not so compact as in the case of the lathe shown last year by Messrs. Stirk, yet

apparently the most has been made of the tool.

Messrs. Craig & Donald showed electrically-driven plate mangles. These are controlled by a tramway type controller, and is one of the few exhibits in the building where the capacity for discovering weak spots, and making mischief, inherent to the nature of the average shipyard and boiler-shop apprentice, has been foreseen, and provided for. Even the controller handle can be removed so that it cannot be left "on" and so start the machine unexpectedly when the "juice" comes on after the meal hour. Moreover, the man or boy who can insert nails in the electric brake used on these mangles must have more than average ingenuity.

Among the large electrically-driven tools, the angle and joist shearing machines, by Messrs. Hy. Pels & Co., deserve notice. Here the drive from the motor to the driven spindle is by means of a "Morse" silent chain. The motor is of course a standard stationary motor, but the combination shows how the standard motor may be adapted to tool work, and a considerable ratio of reduction between it and the driven spindle rendered possible without the use of spur gear, or structural alterations to the machine itself. Such chains are, of course, expensive drives, but it must not be overlooked that they render possible the use of high-speed motors which are cheap. In many cases it is found much cheaper to use high-speed motors with a reduction gear, than slow-speed motors driving more or less direct.

There are other exhibits of heavy tools driven by electric motors, but few present any features of note from a purely electrical standpoint, though the arrangement of the motor on the lathe headstock and planer on Messrs. Pollock & McNab, and Cunliffe & Croom's stands showed that efforts are made to produce a compact self-contained tool. When we come to smaller tools we find that another requirement, viz., portability, has rendered necessary several departures from the lines followed by builders of larger tools. Apart from mechanical refinements, the operating conditions render necessary

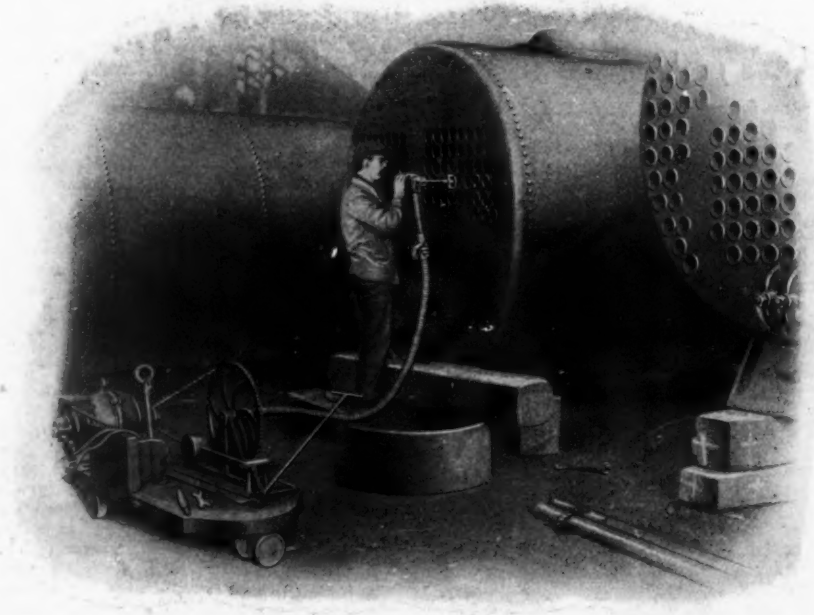


FIG. 1.—ELECTRICALLY DRIVEN PORTABLE DRILLING AND TAPPING MACHINE. CHAS. WICKSTEED & CO.

the use of spur gear to a very considerable extent. Lightness in the motor postulates a motor running at the highest practicable speed, and the requirements of the work render necessary a slow spindle speed. Here only spur gear or some of its modifications is possible, though there were three notable exceptions, viz., Messrs. Wicksteeds' drilling and tapping machines, similar machines made by Messrs. Campbell & Isherwood and exhibited by the United States Metallic Packing Co., and the drill shown by Messrs. J. Butler & Co.

The first of these is well known among engineers; it reveals the inherent excellence of a simple application of the oldest method of transmitting power when combined with excellent design and careful attention to detail.

The motor which drives the machine is a "Lundell" machine of one, two, or three horse power, depending on the size, and it drives, by means of a round belt, a large wheel, to which is attached the flexible shaft which drives the drill head. The chief feature of this drive from the motor is the adaptation of a small tension run, just a miniature of what was used in the days of cable tramways to maintain constant tension on the cable. Fig. 1 shows the machine and the counter-weight, which tends to keep the large wheel away from the motor pulley, and so maintain the belt at uniform tension. This weight may be moved out and in if it is found desirable to increase or decrease the load transmitted. The valuable feature of the appliance is that should the drill or tap stick, and the load transmitted suddenly increase, the weight is overpowered by the pull of the belt, and it rises ever so little, and allows the belt to slip; thus relieving the motor of excessive load, and, what is more important, preventing the torque applied to the drill or tap from exceeding a pre-determined amount, which is insufficient to break the tool. Messrs. Wicksteeds' flexible shaft seems to embody many desirable features, not the least of which is facility for easy repair. As it is merely a number of short lengths of shaft each coupled to its neighbour by a universal joint, the whole enveloped in an armouring, it is readily repaired by an ordinary mechanic.

Another portable tool, of a similar type, but employing a telescopic instead of a flexible shaft, is that made by Messrs. Campbell & Isherwood, and exhibited by The United States Metallic Packing Co. The machine is operated by a direct or alternating current electric motor, and drives the spur wheel, through which the telescopic shaft passes by means of a pinion. There is a universal joint at the drill head.

Another drill which may be described as semi-portable, though coming within a different category, was exhibited by Messrs. Clarke, Chapman & Co., Gateshead-on-Tyne. It is a bench drill, which is so arranged that it might be more accurately described as a miniature radial drill. The motor, which forms an integral part of the machine, is of $\frac{1}{4}$ h.p. and is series wound. The tool is capable of drilling holes from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. diameter, and the machine may be moved out radially from the pillar, and may also be swung round it. A somewhat

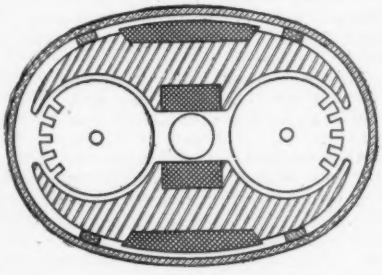


FIG. 2.

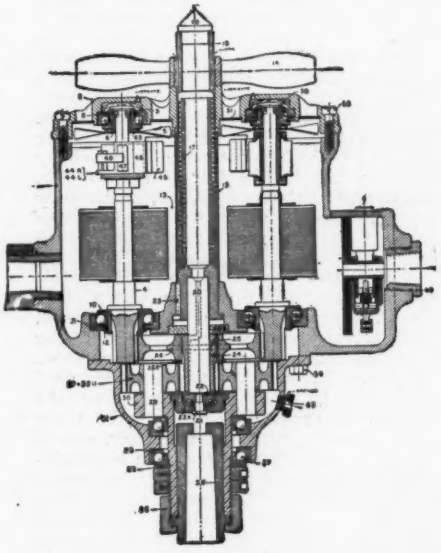


FIG. 3.

similar appliance was exhibited on the stand of the Consolidated Pneumatic Tool Co., who, in addition, showed a complete line of electric tools. Last year we noticed these, but a recent development is a drill having two armatures running in a common field. A cross-section of the driving motor is shown (Fig. 2), while the whole machine opened out parallel to its axis is shown (Fig. 3). The advantages of such an arrangement are that it permits higher motor speeds to be obtained as the armatures are smaller in diameter. This both lightens and cheapens the tool. The disadvantages are that it multiplies the chances of breakdown by two as all the vulnerable parts of the apparatus have been increased in like proportion. The latter is of course largely a matter of design and manufacture, and it does not outweigh the advantages. Another advantage is that it gives a shell oval in shape making it easier to get the tool into corners, and a long feed screw can be used as it goes down the space inside the field magnet, where in the case of single armature machines the armature spindle would prevent such an arrangement.

A number of grinding machines were also shown by this firm. These are suitable for all purposes, and arranged for fixing in the tool post of a lathe, planing, or shaping machine, for internal grinding, for bench work, or for carrying in the hand; the latter are now largely employed for fettling castings.

Messrs. Wolff & Co., Southwark, made an excellent display of similar portable electric tools and grinders; so also did Messrs. Schuchardt & Schutte, Messrs. Ludw. Loewe & Co., and The Light Electric Motor Co., of Ilford. The latter machines embody a few points in the design of the motor, which stamps them as original, for certainly no portable tool which we have ever seen had the armature revolving outside the field magnet.

Large electric generators embodying this feature may be seen in some of the older works supplying Berlin with electricity. The advantages of the arrangement for large machines have often been questioned, but the matter was not finally settled until the firm who made them abandoned the design. It appears, however, to have not a few advantages for portable tools, one of which is that, by reason of the large diameter of the armature, which, by the way, is a ring wound on the *inside*, a very high angular velocity may be obtained with a moderate spindle speed; consequently some sizes have no gearing at all; in others a planetary gear, similar to that used by the Consolidated Pneumatic Tool Co., is employed to get the slow speed necessary at the drill spindle. It may be remarked that the entire outer shell is easily removed, permitting access to the brush gear, &c.

The exhibit of the Phœnix Dynamo Manufacturing Co. was also interesting, though, in this case, the tools exhibited are not exactly portable. A pillar type drill was shown; this has proved very popular with engineers, as it is compact and low in price. It is capable of drilling holes up to $\frac{1}{2}$ in. diameter in iron or steel, and is operated by an electric motor which drives the drill spindle through a friction wheel and disc; the former may be moved along the motor shaft, and by working at various diameters on the disc, give a wide range of speed to the drill spindle. A totally enclosed motor working a combination disc and wheel grinder was also shown (Figs. 4 and 5). This set, which is intended for setting in the tool room, or may be used for many shop purposes, may be supplied with the box base and used on a bench.

An interesting exhibit was the "Prescot" wire welder seen in operation in the annexe. This is made by the British Insulated & Helsby, Ltd. It consists of two clamps brought together by a lever; these two clamps take the ends of the wire to be welded, and the lever brings them together when the welding process is undertaken. Below the clamps is a transformer, which consists of a number of turns of wire which may be connected either to a special alternator or to a public supply if this is alternating. The secondary consists of a single turn of solid copper, so that a comparatively small high pressure current in the primary produces a secondary current of several thousand amperes which passes through the clamps to the ends of the wire to be welded; these ends are of course pressed together when the heavy current passes, and a perfectly homogeneous wire is produced; when properly done there is no trace whatever of the weld.

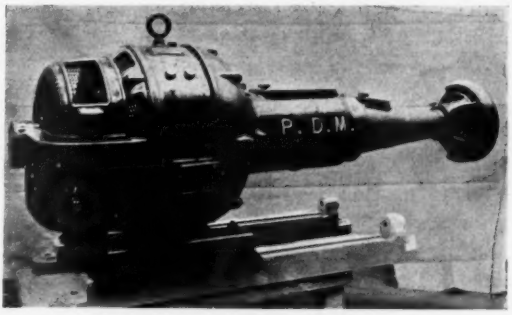
This welder is made in several sizes for wire and small rods, and should prove a valuable appliance to a wire worker.

An exhibit of a different nature was that of the Mordey Fricker Electric Meter Co., who showed several meters of varying size.

The prepayment meter is an ingenious electrolytic meter, its operation being based on the fact that the passage of an electric

current through a suitable electrolyte dissolves a certain quantity of metal from the anode or metal pole at which the current enters the solution. In this case, the insertion of a penny, a sixpence, or any other coin, permits a proportionate length of copper ribbon to be unwound from a roll, and immersed in the solution of copper sulphate.

The passage of the electric current gradually dissolves the copper ribbon, and when it is all dissolved the circuit is broken at the surface of the liquid, and a further coil winds in more copper ribbon. Unlike other prepayment meters, there is no mechanical switch, and the parts of the meter are inexpensive and easily renewed. It should be noted that the copper is not wasted, for as the ribbon is dissolved an equivalent amount is deposited on the cathode, or point where the current leaves the solution, so that the loss is only that due to the difference in price between ingot copper and sheet copper, and as the amount used in each meter is very small, this is almost negligible.



FIGS. 4 AND 5.—ELECTRICALLY DRIVEN DISC AND WHEEL GRINDERS. PHŒNIX DYNAMO CO.

The Linolite Co. exhibited "Tubolite," which is too well known to require much explanation. Judging by the effects at many stands, it appears to be one of the best methods of illumination for this class of work. The tube lamps lend themselves to use in angles and corners, in a manner which no other lamps do. Their outstanding advantage, and one which cannot fail to be appreciated by exhibitors of machinery, is that they illuminate the parts desired without the source of the light being unduly obtrusive. All that catches the eye is the light reflected from the parts on which the rays are projected. The difference between such a method of illumination and the usual arrangement has to be seen to be appreciated.

Messrs. Bergtheil & Young exhibited a variety of fans. The electrically operated punkah is a type of fan which is novel and efficient, the small motor, instead of turning blades at a slow speed, as the usual ceiling fan motor does, causes a screen carried from the roof by two rods to oscillate backwards and forwards, by means of a friction disc which rubs alternately on one side and then another of the friction disc which takes the place of the motor pulley. The effect is excellent, and it should prove extremely popular in tropical countries where electric supply is available. A fan with a single-phase alternating current, having large starting torque, about two and half times the normal, and capable of speed regulation down to zero, was shown on this stand. The motor is of the single-phase repulsion type. There are few examples of this type of motor applied to industrial purposes, though it is probable that, as their advantages are more widely recognised and appreciated, they will be found even on circuits where polyphase current is supplied, operating, of course, on one leg of the system.

This firm showed a printing press controller of excellent design. It is entirely operated by push buttons, one of which closes the main circuit; two others are employed, one for increase in speed and another for a decrease; neither of the two latter have any effect whatever if the push button closing the main circuit has not been pressed. The main switch is operated by a solenoid, and the moving of the contact lever over the contacts is effected by a small motor, the movements of which are controlled by the two push buttons already

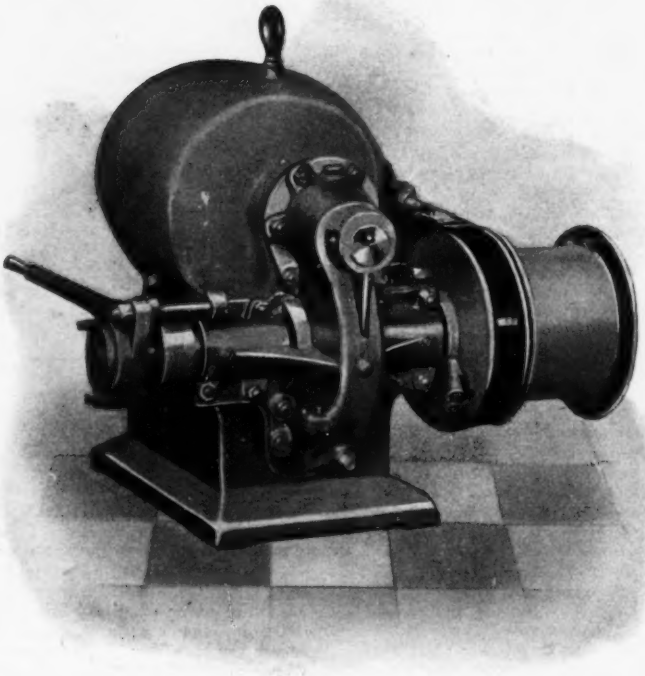


FIG. 6.—ELECTRICALLY DRIVEN BAGGAGE WINCH. CLARKE, CHAPMAN & CO.

mentioned. The lever stops on the contact over which it is passing immediately the button is pressed, and if the previous movement has been for increased speed, simply pressing the button for decreased speed gives a gradual reduction in speed until the button is pressed, when the speed remains constant at that point. The push button switches have two plungers acting on a rocking lever which carries the small contact arm.

Among other apparatus which does not come within the category of tools or controlling gear, the electrically-driven winches exhibited by Messrs. Clarke, Chapman & Co. deserve notice. These consist of a winch suitable for dock or shipyard use, similar in most respects to the usual steam winch. The other exhibit, viz., a baggage winch, is remarkably compact (Fig. 6). It is operated by a 3½ h.p. electric motor geared to the winding drum by a worm gear.

In conclusion may be mentioned the "Percival" self-sustaining arc lamp winch, shown by B. Metz, the distinguishing feature of which is that it is direct driven—that is to say, each turn of the handle gives one complete revolution of the drum, and at all times the load is self-sustaining either when raising or lowering, as immediately the handle is released the drum becomes locked and the load is sustained. This effect is obtained without the use of ratchets or pawls, which have often proved liable to cause accidents.

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**THIRD PRIZE COMPETITION.—The awards made in connection with this will be announced in the next number, in which will also appear particulars of another competition of interest to Works Managers, Foremen, Machinists, &c.**